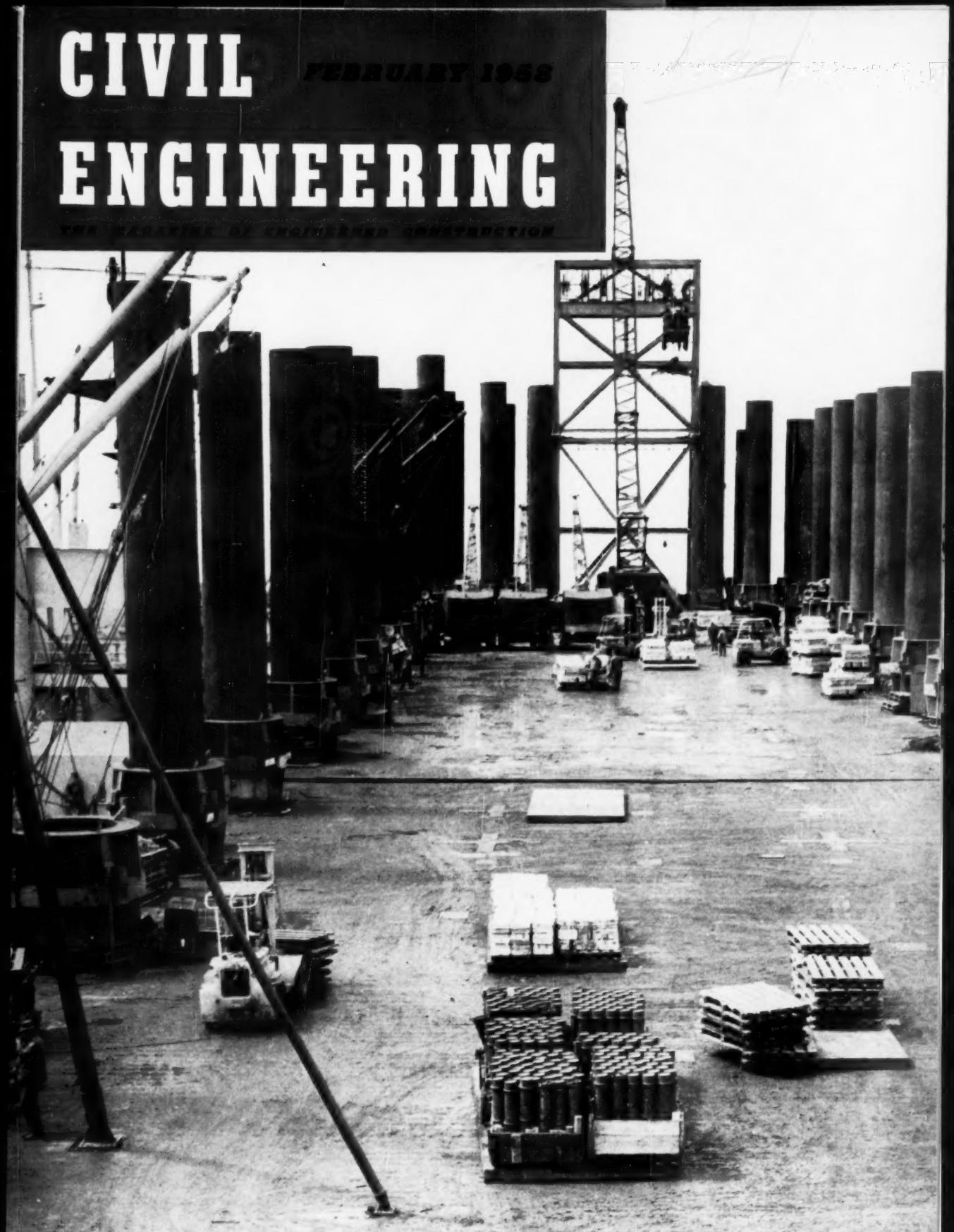
CIVIL ENGINEERING

FEBRUARY 1968

THE MAGAZINE OF ENGINEERED CONSTRUCTION



DELONG PIER IS CONNECTED TO SHORE BY AERIAL TRAMWAY. SEE ARTICLE BY LEWIN.

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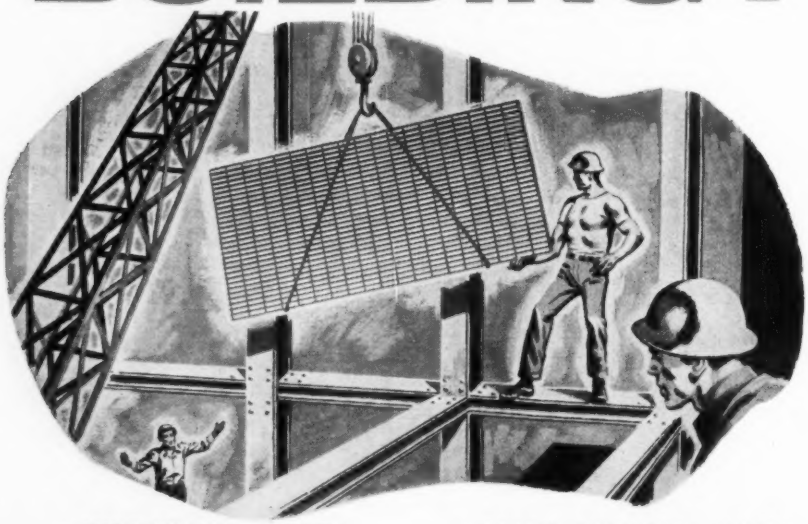
BUILDING?



? INDUSTRIAL PLANTS
? POWER HOUSES
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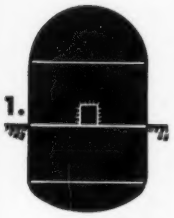
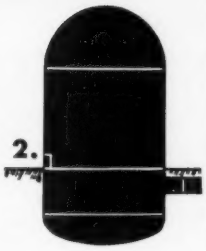
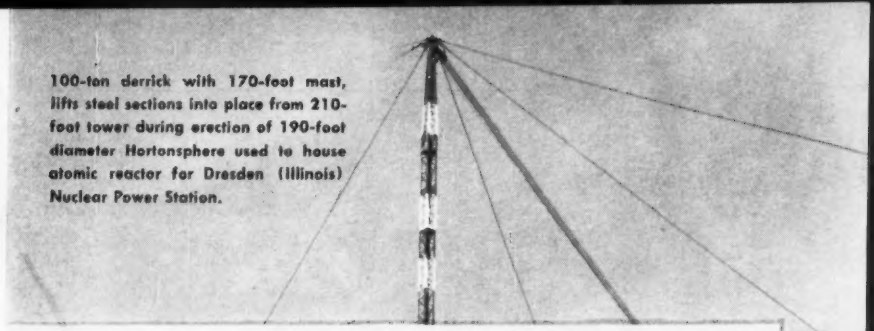
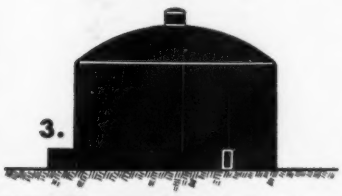


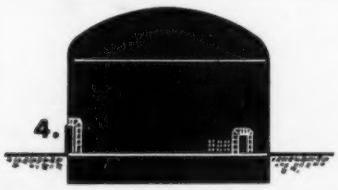


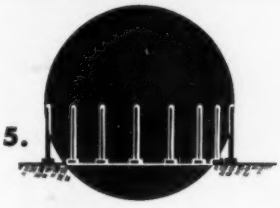


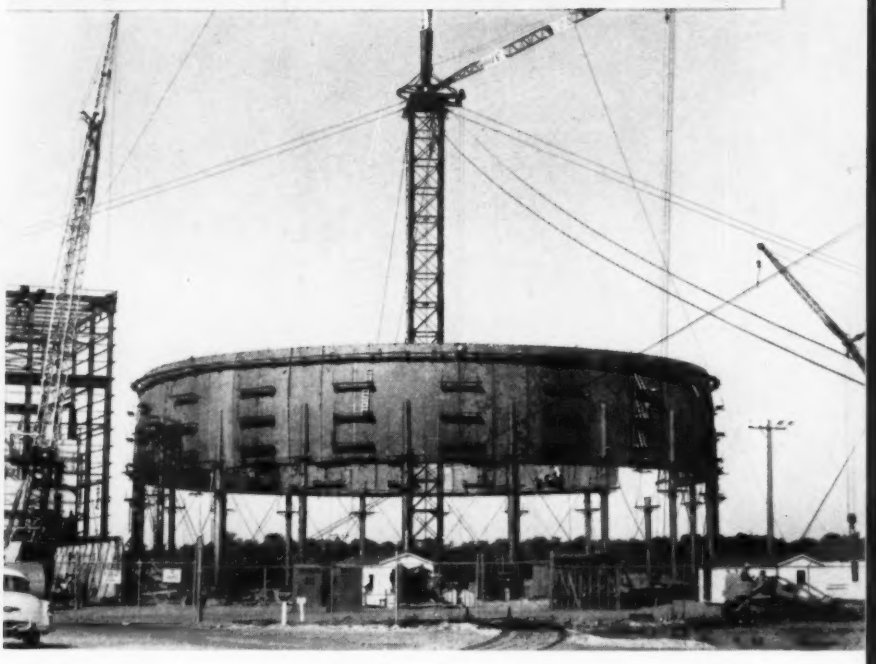
100-ton derrick with 170-foot mast, lifts steel sections into place from 210-foot tower during erection of 190-foot diameter Hortonsphere used to house atomic reactor for Dresden (Illinois) Nuclear Power Station.

SHAPES OF things to come in the atomic age









CB&I Structures to Silhouette Major Reactor Projects

For CB&I engineers, fabricators and erection specialists, the challenge of things to come in the atomic age is, to a large extent, a reflection of existing accomplishments.

In 1954 the world's largest sphere, a Hortonsphere® measuring 225 feet in diameter, was built by CB&I for the AEC Knoll Atomic Power Laboratory at West Milton, New York, for testing a prototype of the atomic power plant which now serves our atom sub fleet.

Today, near Chicago, a skilled CB&I crew is completing the erection of a 190-foot diameter Hortonsphere to house an atomic reactor for the Dresden Nuclear Power Station. Near Detroit, another CB&I crew erected a reactor containment vessel of a different design for the Enrico Fermi Atomic Power Plant. Silhouettes of similar structures, being designed, fabricated or erected by CB&I, are shown here.

Yes, for CB&I, the shape of things to come in an atomic tomorrow had their beginnings *yesterday*. Experience gained in almost 70 years of furnishing *craftsmanship in steel* to serve Industry, Government and scientific research is now meeting the exacting requirements for reactor containment vessels.

E53CB

1. Enrico Fermi Atomic Power Plant, Lagoona Beach, Michigan. (Power Reactor Development Co., Architect-Engineers)
2. U. S. Air Force, Dayton, Ohio
3. Atomic Energy Commission, Livermore, California. (John W. Cowper, Purchaser)
4. Massachusetts Institute of Technology, Cambridge, Massachusetts. (Foster Wheeler Corp., Engineers)
5. Dresden Nuclear Power Station, Dresden, Illinois. (Bechtel Corp., Constructor-Contractor)

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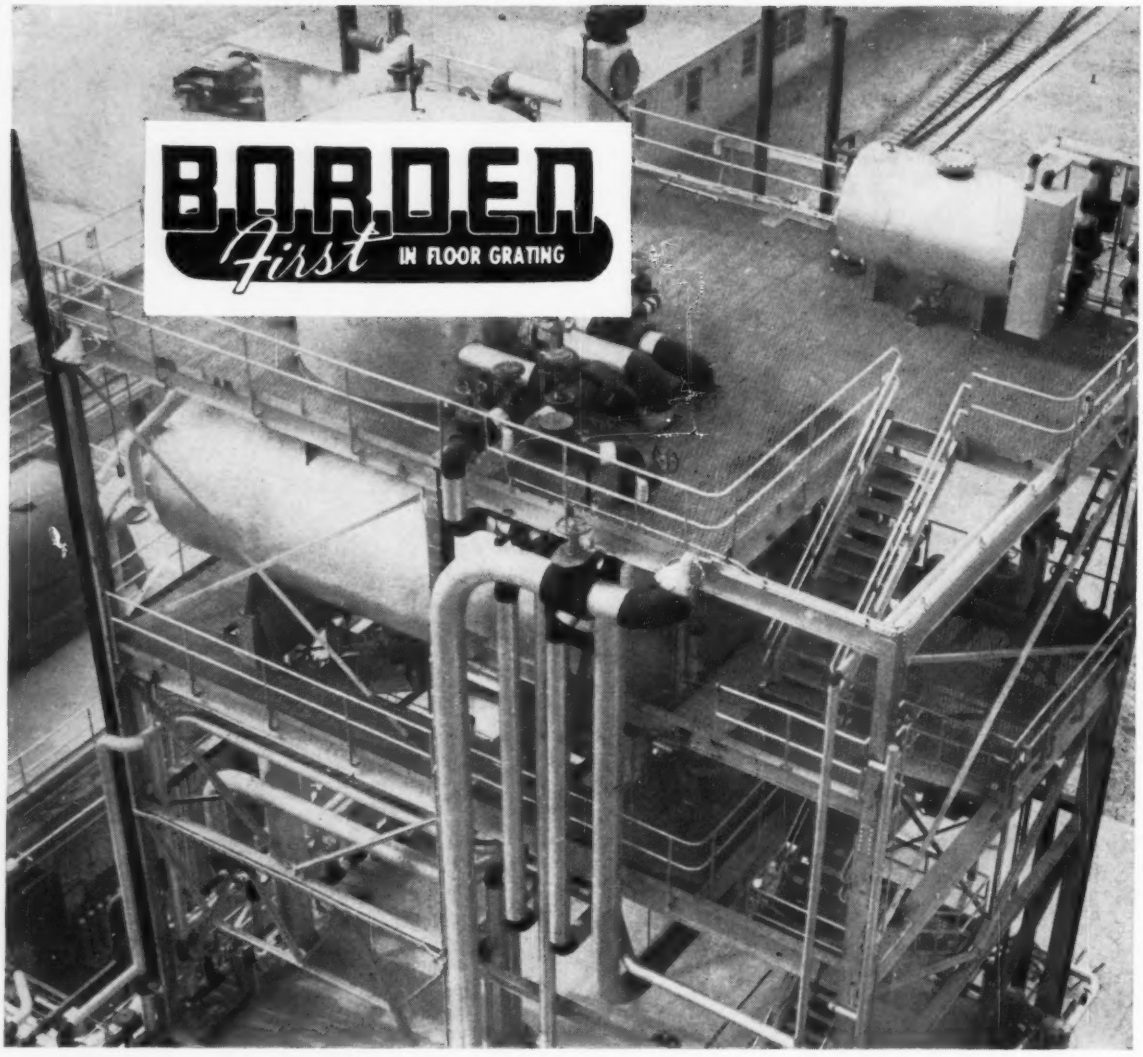

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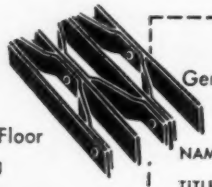

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Associate Editor • Ruth G. Campbell
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Advertising Manager • James T. Norton
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CIVIL ENGINEERING

FEBRUARY 1958

VOL. 28 • NO. 2

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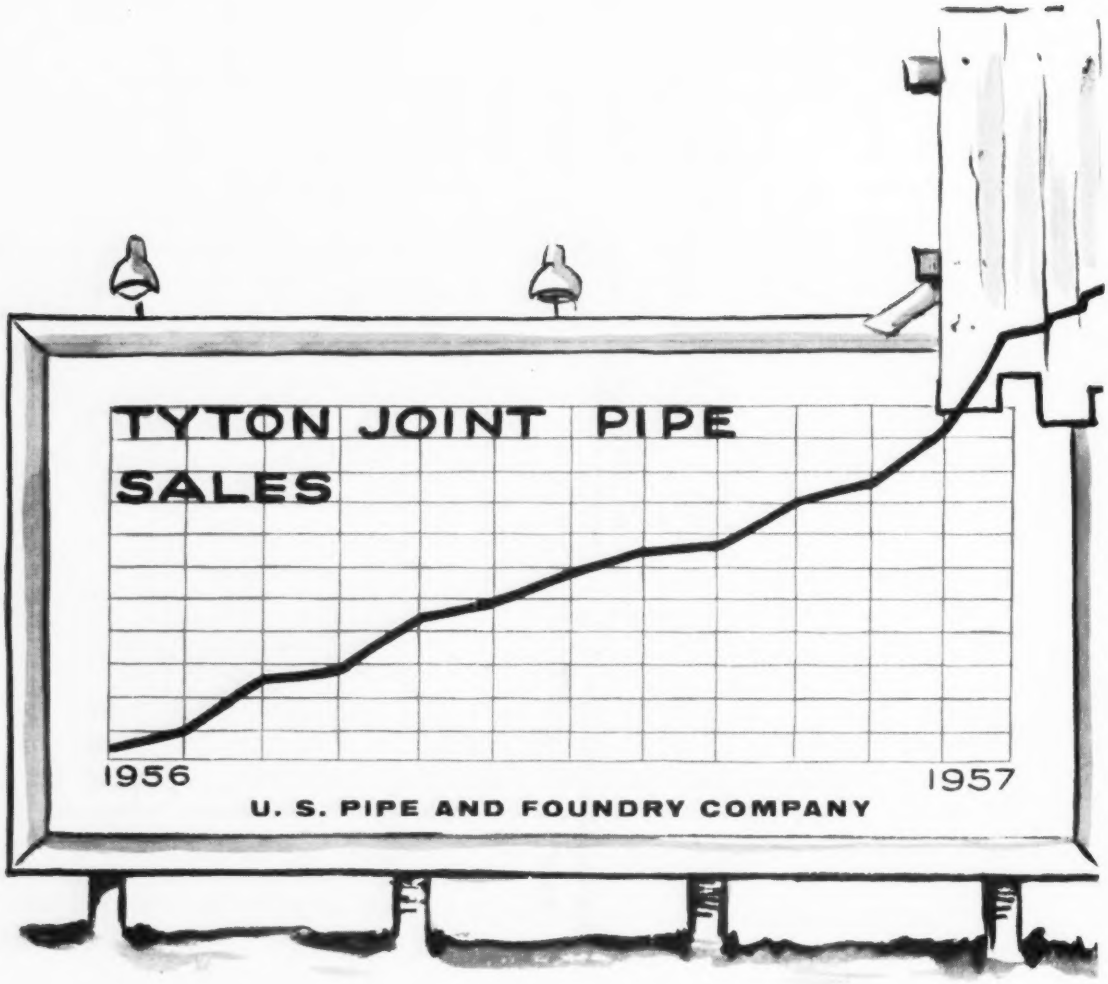

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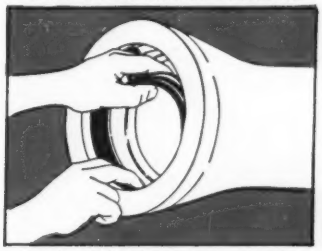
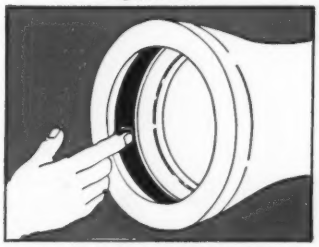
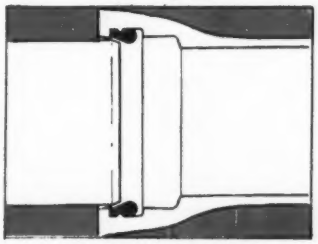


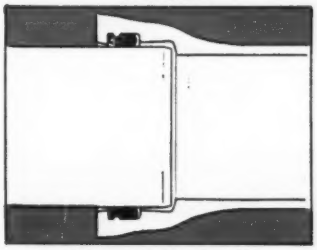
Insert gasket with groove over bead in gasket seat



Wipe a film of special lubricant over inside of gasket



Insert plain end of pipe until it contacts gasket

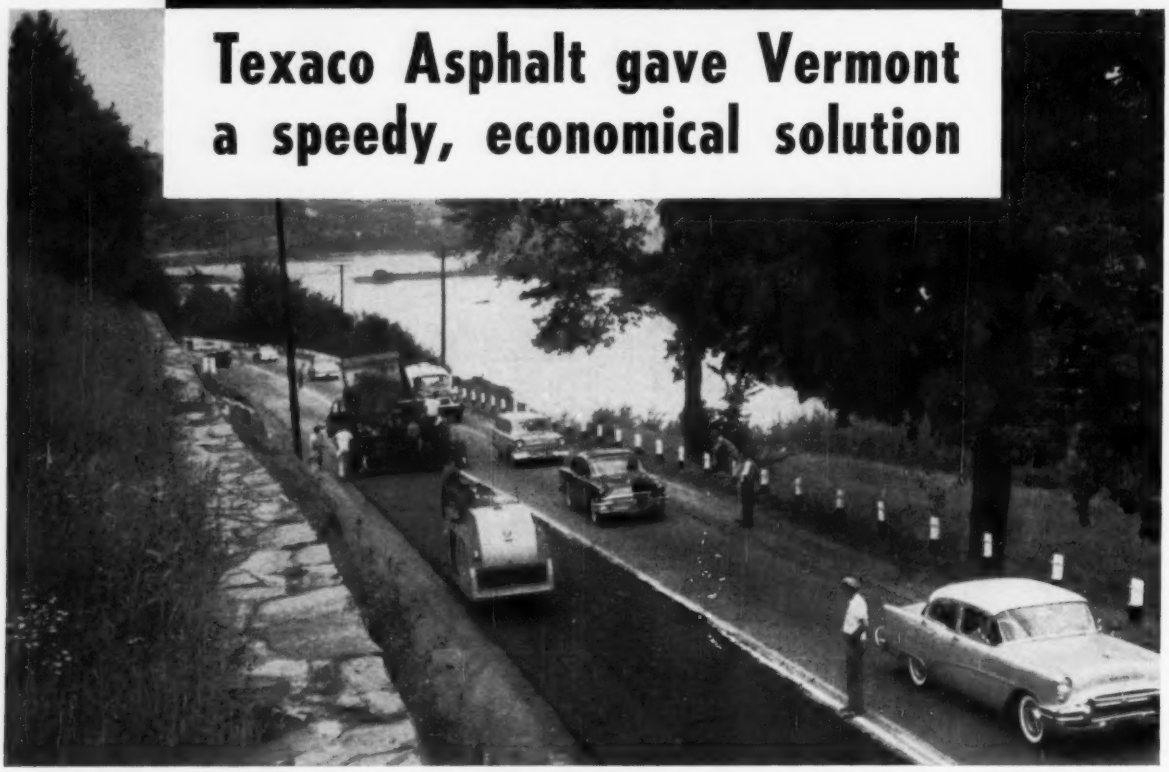


Force plain end to bottom of socket . . . the job's done!

20" Tyton Joint pipe being installed for water supply line in Alabama.

Traffic outgrew this highway

Texaco Asphalt gave Vermont a speedy, economical solution



Modernizing US-5 in Vermont with a plant-mixed Texaco Asphaltic Concrete wearing surface, laid without interrupting traffic.

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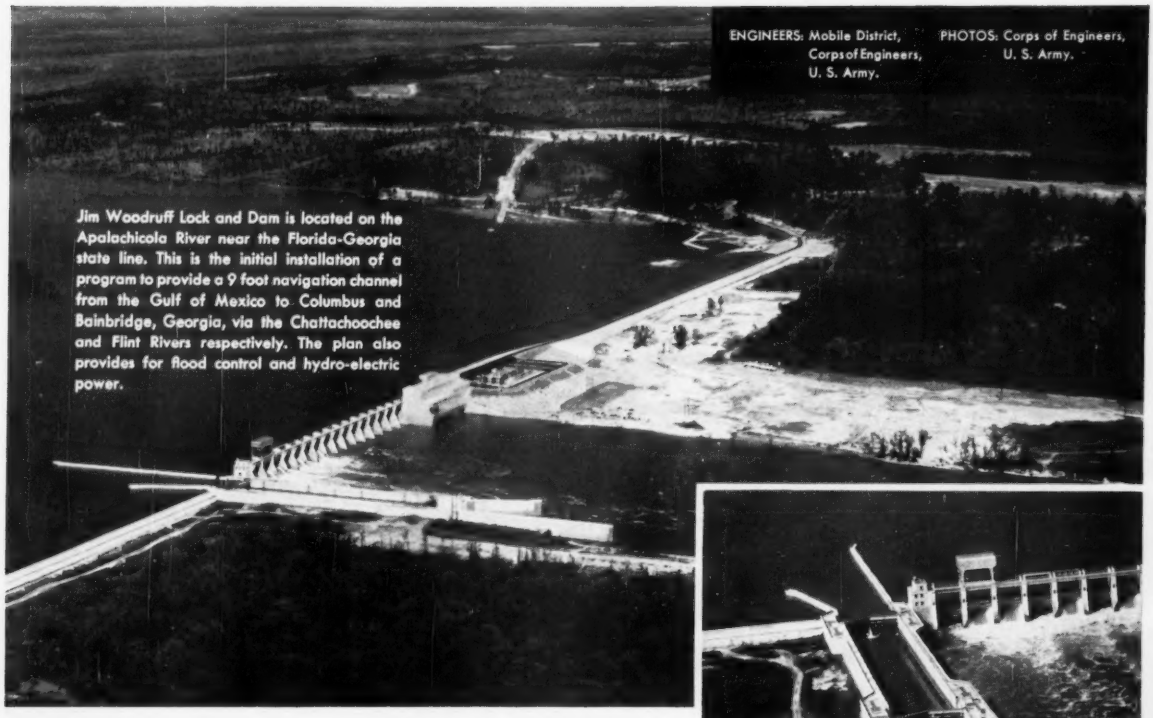


ENGINEERS: Mobile District, Corps of Engineers, U. S. Army.

PHOTOS: Corps of Engineers, U. S. Army.

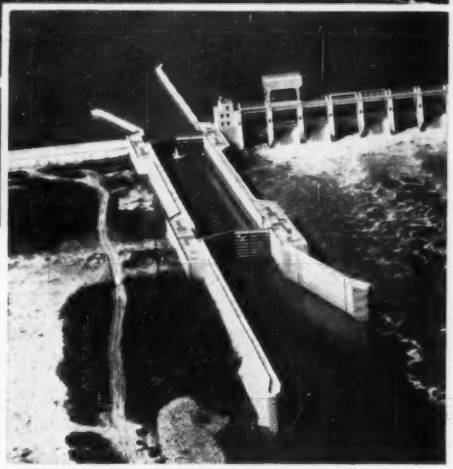
Jim Woodruff Lock and Dam is located on the Apalachicola River near the Florida-Georgia state line. This is the initial installation of a program to provide a 9 foot navigation channel from the Gulf of Mexico to Columbus and Bainbridge, Georgia, via the Chattachoochee and Flint Rivers respectively. The plan also provides for flood control and hydro-electric power.

Intrusion grouting eases construction problems at Jim Woodruff Dam

The Jim Woodruff Lock and Dam Project, recently completed under the supervision of the U. S. Army Corps of Engineers, is a typical example of how effectively INTRUSION* grout can control sub-surface water. Investigation at the dam site indicated a layer of water-bearing Tampa limestone under the entire area. Army Engineers determined that extensive grouting would be necessary to prevent seepage under the dam, to increase load bearing capacities, and to hold excessive water out of excavations.

The excavation for the lock was to go 30 feet below normal river level. As material was removed to form a cofferdam, the lock area was surrounded with a temporary curtain of sanded INTRUSION grout for a total perimeter distance of some 2800 lineal feet. Grouting was not intended to stop leakage into the cofferdam but only to reduce it to a volume that could easily be handled by pumping. When excavation exposed the Tampa limestone layer, only minor seepage was evident. Even when a flood raised the river level another ten feet, the increase in water flow was very slight.

INTRUSION grout was also used under the fixed crest spillway, (large photo—left) and the gated spillway and power house, (center) to increase load bearing and to seal the permeable limestone. When lock construction was completed, a grout curtain was placed around it to minimize uplift pressures.



Usable lock area measures 82 x 450 feet. Maximum lift is 33 feet.

Cofferdam grouting held seepage into lock construction area to minimum. Primary grout holes were drilled on 20 foot centers. Secondary holes halfway between primaries showed Intrusion grout had penetrated limestone voids for a 10 foot radius around initial holes.

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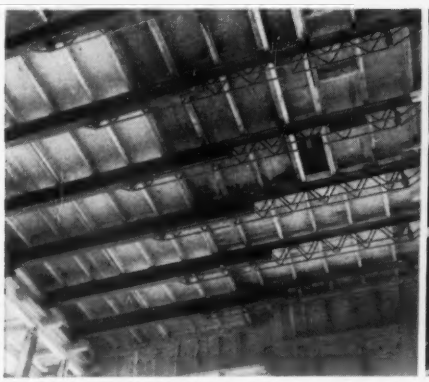

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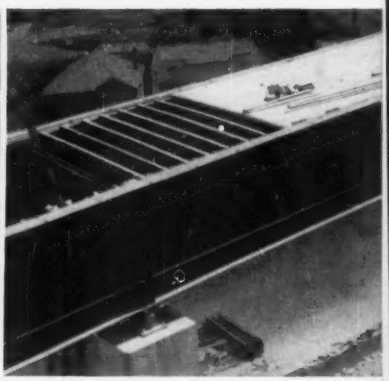

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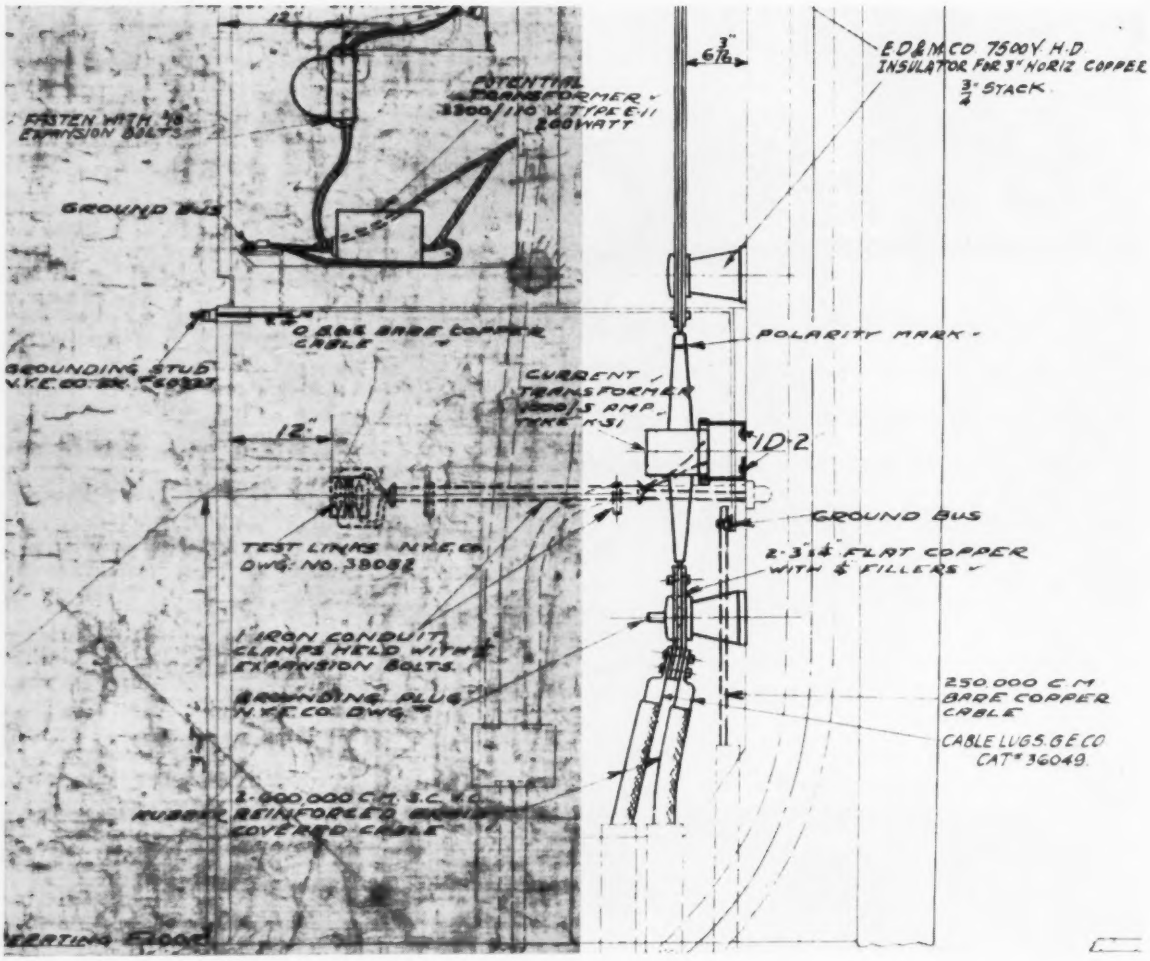
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GROUNDING STUD
CURRENT TRANSFORMER
12"
TEST LINKS N.Y.E.CO. DWG. NO. 38082
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Here are two white prints spliced together for your comparison. The copy on the left was made from a sensitized cloth intermediate. This intermediate, and the print produced from it, bear the same scars of age and wear as the old original drawing.

To make the copy on the right, the worn original was reproduced on CRONAFLEX, Du Pont's amazing new engineering reproduction film. See how the CRONAFLEX intermediate has eliminated the kink marks, cleaned up the smudging, actually improved the drawing.

CRONAFLEX improves the copies of your drawings for several reasons. First, the physical characteristics of the films eliminate the kink and smudge marks from the prints. Second, the high contrast of CRONAFLEX gives you better intermediates, which means more legible blue or white prints. Third, because of the unexcelled matte surface of CRONAFLEX, you can do additional drafting or make corrections on "second originals" quickly, easily, and accurately.

CRONAFLEX engineering reproduction films are extremely versatile. They are available in three types: Direct Positive, Contact and Projection. All CRONAFLEX films are on Cronar® base, assuring unbelievable ruggedness, high dimensional stability, minimum moisture absorption.

CRONAFLEX will not tear, kink, shatter or become brittle with age or handling. CRONAFLEX has a matte finish that provides the finest pencil or ink acceptance. Lines do not smudge. Reproductions are cleaner, sharper, more legible.

Shouldn't you specify CRONAFLEX for your intermediates and "second originals"?

FOR MORE INFORMATION on CRONAFLEX, write to: E. I. du Pont de Nemours & Co. (Inc.), Photo Products Department, Wilmington 98, Delaware. In Canada: Du Pont Company of Canada (1956) Limited, Toronto.

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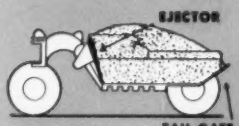
FROM ST. LAWRENCE SEAWAY TO CALIFORNIA

YUBA

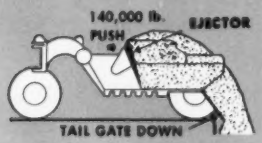
Movall

Dumping glue-like clay on St. Lawrence Seaway. "Better than any other hauling unit for this type of work" says contractor.

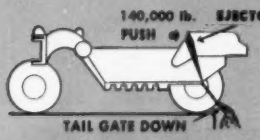
Accurately spreading surfacing material in fifth gear at Mather Air Base, California. No tractor or motor grader was used.



LOADED — The big target, big capacity body carries its load low, maintaining high ground clearance since frame and body are integral and compact.



DUMPING — Level body offers no gravity resistance, with potential 140,000 lb. ejector push assuring complete positive discharge with minimum use of power.



EMPTY — Sides and bottom are scraped clean, eliminating need for "mucking out" or decreasing capacity for next full load. Complete ejection takes only 11 to 14 seconds.

This rugged multi-purpose high speed hauler outperforms rear-dumps and bottom-dumps on most every type of off-highway job

Earthmoving that only a MOVALL can do at such high profit

Exclusive level action positive ejector spreads surfacing material on the fly, completely unloads sticky clay or any top loading material. Full stability during all operations, high clearance, short turning radius, big capacity, and less downtime mean *more profits* on *more types of jobs.* See your Allis-Chalmers, Caterpillar, or International Harvester Dealer – or phone or write Yuba direct. *Now is the time.*

MA-803

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Paceco first to calculate exact sizes of hydro gate hoists

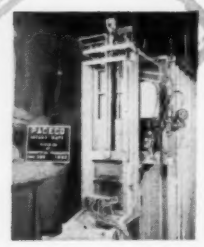
...ASSURING LOWER COST AND GUARANTEED PERFORMANCE!

Now, for the first time in engineering history, Paceco has developed a formula to determine the exact downward pressure on water control gates...the exact power required from gate hoists.

Pacific Coast Engineering Company has completed a research project in cooperation with the Hydraulic Research Laboratories, Division of Industrial Research, State College of Washington; to determine variables in size and design of gates and hoists for water control; to develop formulae to determine accurate, safe performance. Objectives accomplished!

This research project was conducted in connection with the Paceco contract with Merritt-Chapman and Scott Corporation to furnish a 540-ton capacity crane to simultaneously handle three emergency intake gates at the Priest Rapids Project on the Columbia River. As a result of Paceco's tests, the original estimate of 540-ton capacity requirement has been discarded. 390-ton capacity will serve better, with lower first cost—guaranteed performance!

Paceco tests reduced 540 tons estimate to 390 tons exact requirement



Downstream view of gate well section showing gate and gate hydraulic control system.

Test apparatus showing air bubble flow pattern for typical gate lip.

Pacific Coast Engineering Company invites your inquiries on cranes, hoists, gates and other similar types of major mechanical equipment. May we put to work for you Paceco's research, designing and fabricating skills? Write for brochure G.

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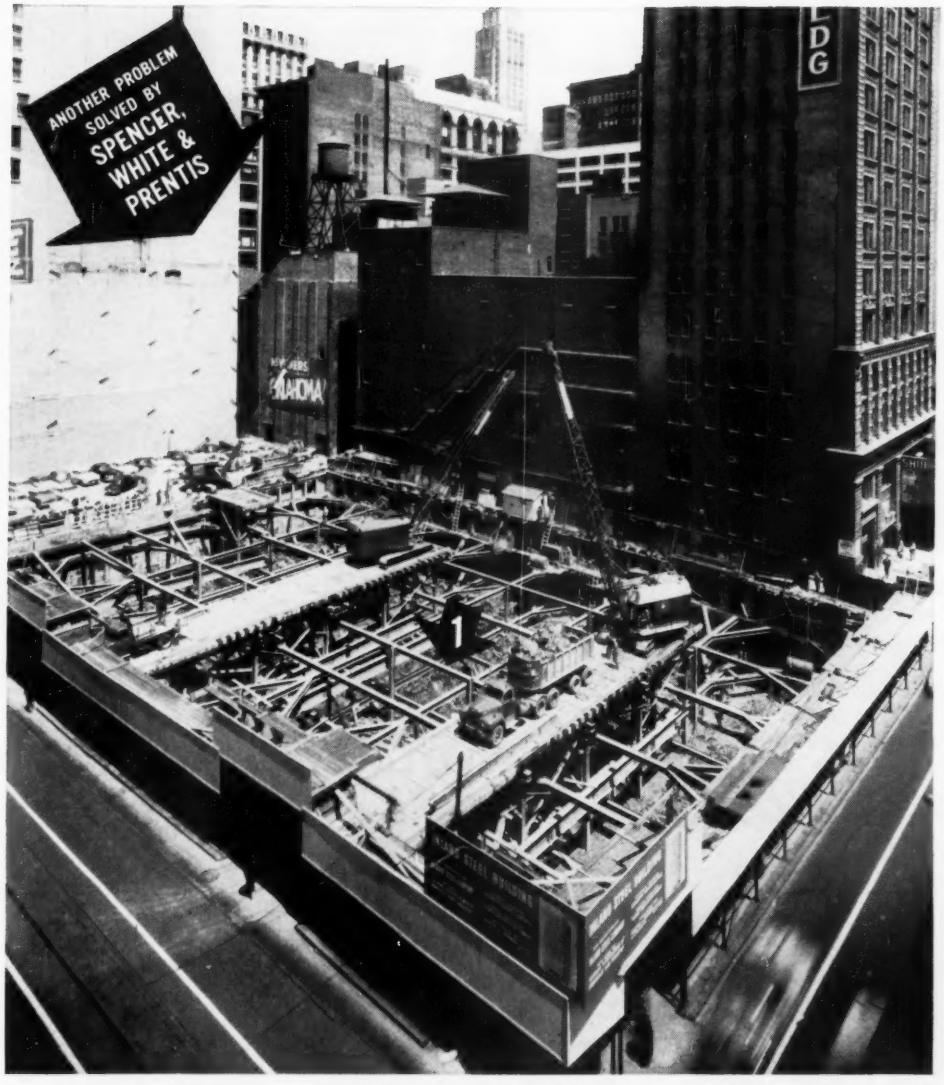

Project: New Inland Steel Building, Chicago, Ill.

Architects: Skidmore, Owings & Merrill, Chicago, Ill.

General Contractor: Turner Construction Co.

1. PRETEST CROSS-LOT BRACING.

43 FT. EXCAVATION IN CLAY:

Here's how Pretest bracing, plus horizontal sheeting and soldier beams, successfully solved problems of complex foundation job

This 19-story, unique steel structure required one of the deepest excavations of its kind in Chicago (43 ft. below curb). Problem: excavate and sheet in soft clay . . . install 393 steel bearing piles for a foundation . . . do all this without imperilling adjacent buildings, streets, subway tunnel.

How Spencer, White & Prentis specialists matched wits with these obstacles is shown in the photo above. Together with horizontal sheeting, Pretest bracing played a big role. This method (like our Pretest underpinning) assures that the full pressure is carried, thus minimizing movements.

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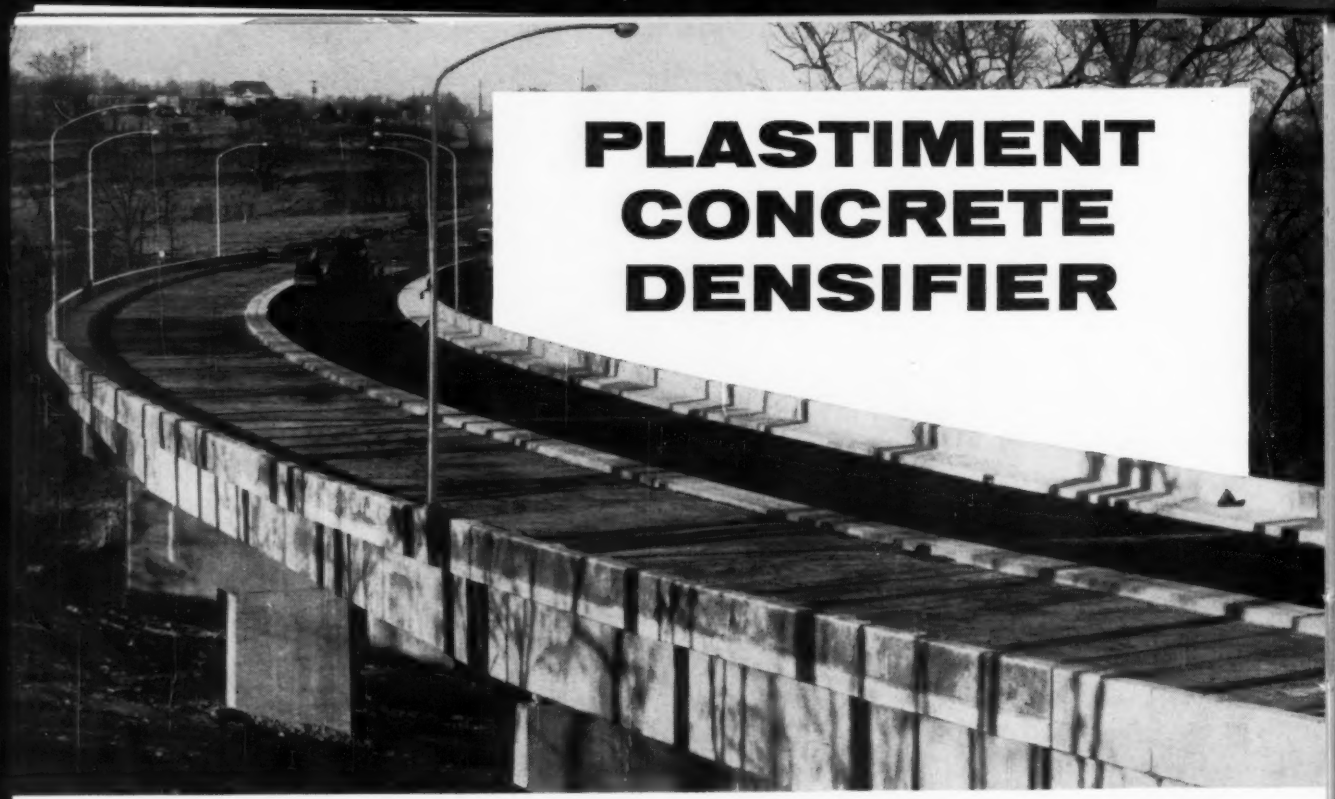
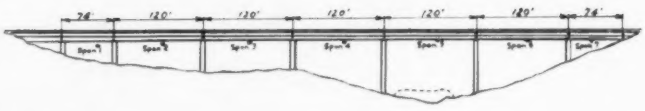


PLASTIMENT CONCRETE DENSIFIER

Specified FOR PHILADELPHIA'S GORGAS LANE BRIDGE



Plastiment concrete in 7 foot deep beams is being revibrated before deck is placed.

This unusual monolithic prestressed beam and slab design resulted from alternate bids permitted by Philadelphia's progressive Department of Streets* . . . Savings of more than 20% over conventional steel design were passed on to the taxpayers.

Each 120 ft. long span, 34 ft. wide; including two traffic lanes, sidewalk, and half of the center median strip was concreted in one continuous 260-yard operation . . . Since 8-10 hours elapsed during placement, Plastiment was specified to control initial set. Plastiment provided these additional benefits: better compaction, greater density, and faster development of stressing strength.

Your clients will benefit from the better structural quality of Plastiment concrete . . . Specify Plastiment for your next job . . . Write for Bulletin PCD.

AD 26-7

*David M. Smallwood, Street Commissioner
Noel W. Willis, Chief Bridge Engineer

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The Conduit & Foundation Corporation, Philadelphia—Contractor

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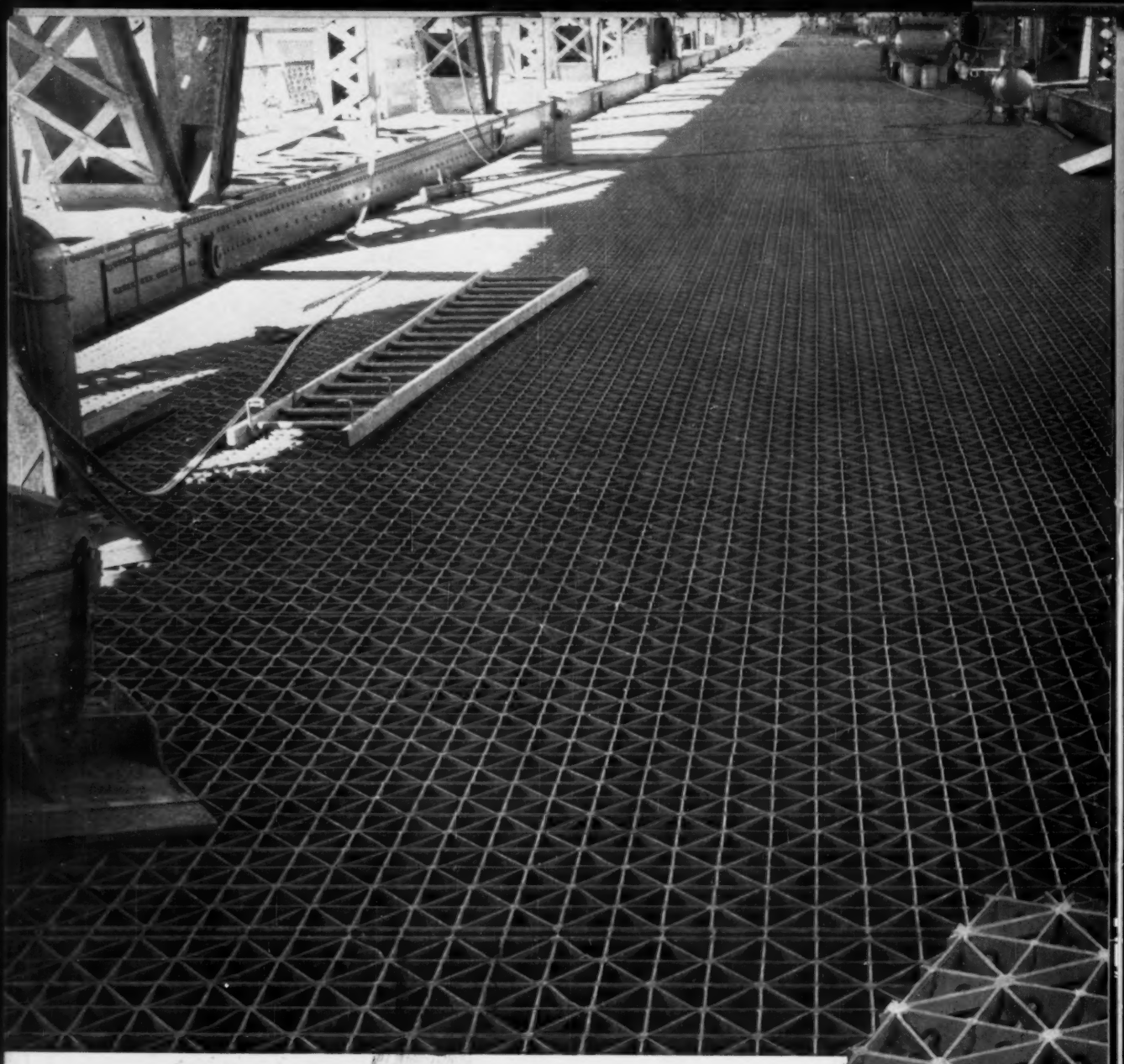
ALFRED A. RAYMOND AWARD

An award of $1,000 will be given annually in honor of Alfred A. Raymond, inventor of the cast-in-place concrete pile and founder of Raymond Concrete Pile Company. It will be presented to the author of the best original paper on "Design and Construction of Foundations for Structures," as selected by a committee of eminent judges. Authors of manuscripts, to qualify, must hold a degree in engineering from an accredited institution.

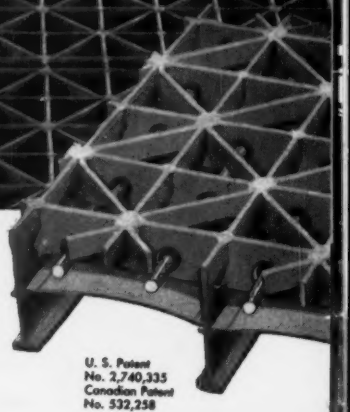
The topic "Design and Construction of Foundations for Structures" is to be interpreted broadly. It covers all phases of foundation engineering from the initial planning to the final installation of a foundation for a structure. Engineers are cordially invited to submit a paper on whatever aspect of foundation engineering or construction of foundations will contribute to knowledge in the field. Manuscripts may deal with foundation test borings, soil mechanics, the theory of foundation design, actual foundation construction, either temporary or permanent, and other related subjects. (*All papers must be submitted by September 1, 1958.*)

If you are a practicing engineer, engineering faculty member or a graduate student and wish to compete for this award, simply write for a complete set of detailed regulations: Dept. C, Alfred A. Raymond Award, Room 1214, 140 Cedar Street, New York 6, N. Y.



STRONG, RIGID and TRUE *Beneath the Concrete:*

GREULICH 4-WAY GRID

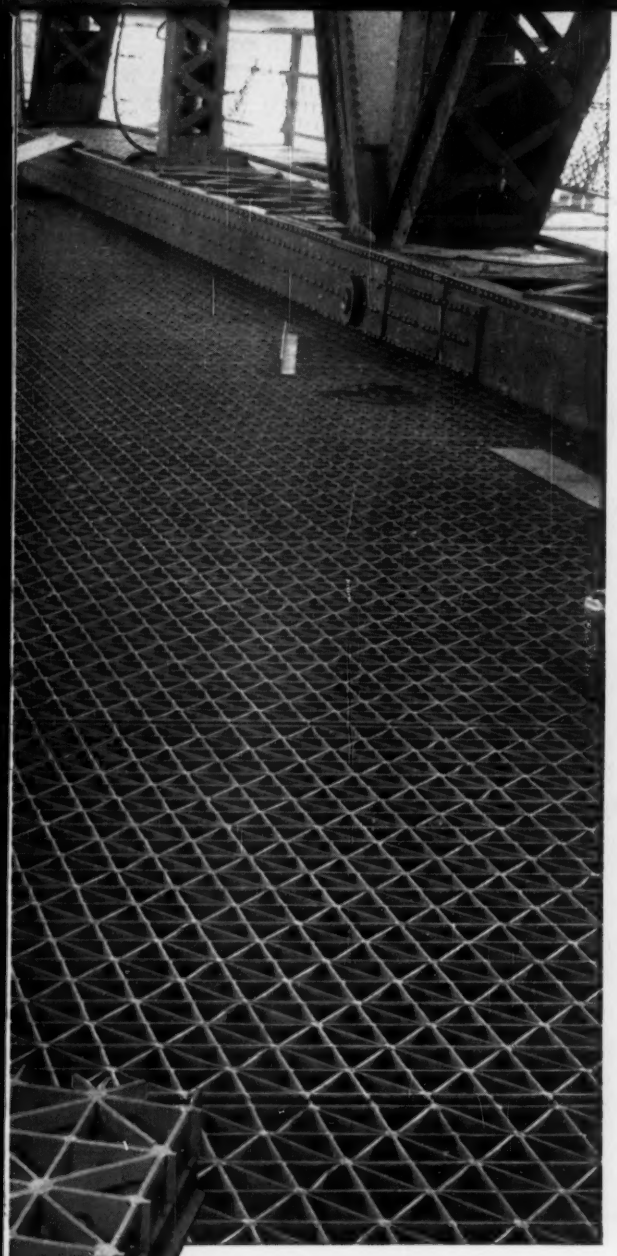


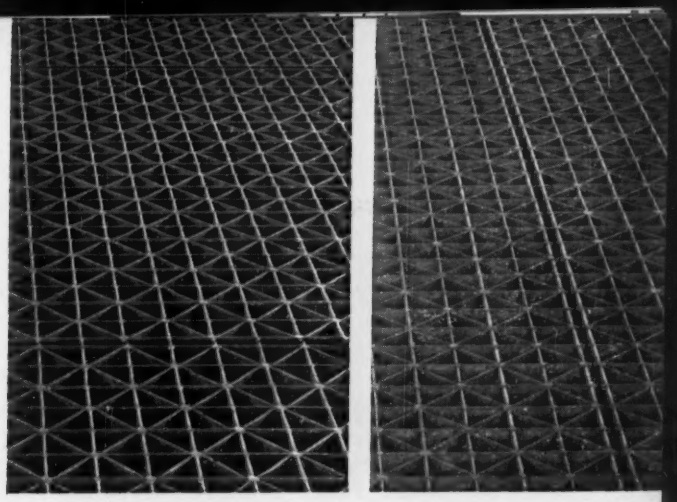
U. S. Patent No. 2,740,335
Canadian Patent No. 532,258

From now on motorists who travel along the lower deck of the famous Rock Island bridge will find a smooth, flat ribbon of concrete stretching across the Mississippi from Rock Island, Illinois to Davenport, Iowa. Beneath the concrete—providing a flat, single-plane surface and the strength and rigidity—lie the roadwidth units of Kerrigan open steel bridge flooring used by F. K. Ketler Company, contractors, in the modernization of the double-deck bridge. Modjeski and Masters were designing and consulting engineers to the U. S. Army Corps of Engineers and the Chicago, Rock Island & Pacific R. R.

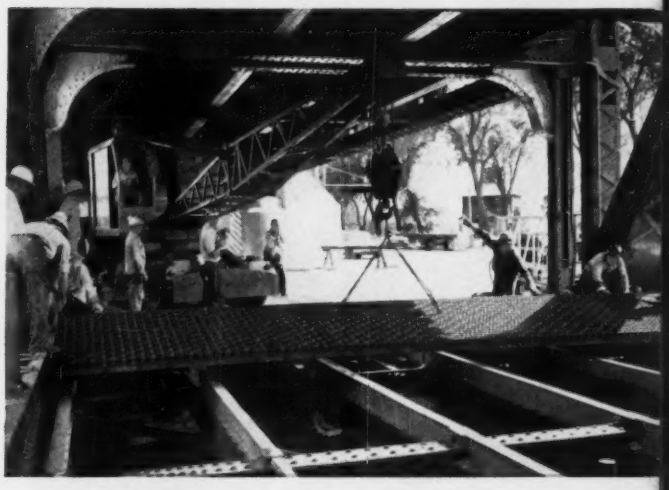
Kerrigan open steel bridge flooring in the new Greulich 4-way grid design is precision manufactured in 5-inch deep units with integrally connected triangles. Bearing members are spaced 7½ inches apart (cutting field welds by 20%). Roadwidth units (in lengths up to 42 feet) are fabricated in 7-foot, 3-inch panel widths—a size which cuts handling costs to a minimum but still permits hauling on ordinary flat-bed trucks. Maximum rigidity keeps units true during shipping, handling and erection; and assures true alignment. Test data is available.

General Sales Office, 274 Madison Avenue, New York, New York





Note true alignment of panels running in both directions in above photographs. This same alignment can be duplicated mile after mile since flooring is manufactured in precision jigs.



Economical field erection was clearly demonstrated in the modernization of th famous double-deck Rock Island Bridge. Roadwidth panels of Kerrigan GREULICH 4-WAY GRID were swung into place to form a flat, single-plan roadway. Installation by Whiting-Turner Corp., Baltimore.

Then the heavy transit mixers were driven on to the roadway, and the grid, complete with built-in forms (resting on carrying ribs rolled into the beams) and reinforcing rods, was then filled half depth with concrete to specifications drawn by Modjeski and Masters, Harrisburg, Pa., consulting engineers.

- **Stronger**
- **Quieter**
- **20% Fewer Welds**

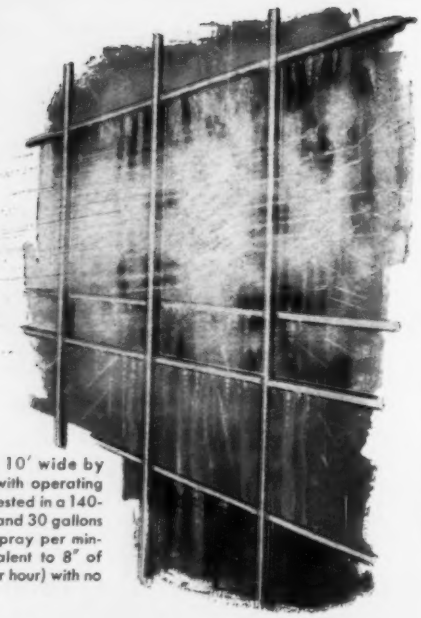
For additional information, test data and list of bridges in Ga., La., Fla., Mass., Ill., Md., Minn., and Penn., which you can inspect, write Harvey F. Neel, Gen'l. Mgr., Div. G-9, Kerrigan Iron Works, Inc., Nashville, Tenn.

THE FORGES OF KERRIGAN

KERRIGAN IRON WORKS, Inc.

Bridge Flooring Division (Harvey F. Neel, Gen'l. Mgr.), Nashville, Tenn.

New Versatile-Wall offers weather-

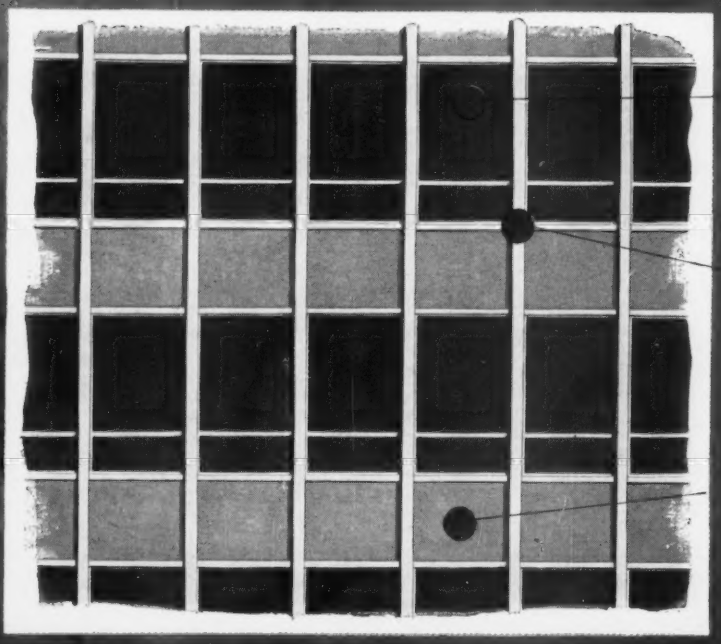


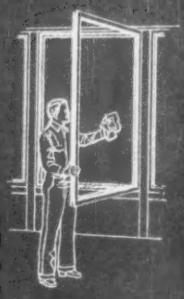
A section 10′ wide by 14′ high with operating sash was tested in a 140-mile wind and 30 gallons of water spray per minute (equivalent to 8″ of rainfall per hour) with no leakage.

With Robertson Versatile Wall, architects and engineers can enjoy full freedom of expression in the use of modular units and colors and still be sure of the precision of fit necessary to resist the ravages of weather. Developed after years of experience, research and testing, this curtain-wall system combines the advantages of standard units with the artistic latitude of tailor-made walls.

The results of extremely severe tests proved beyond a doubt that the rugged, weathertight construction of Robertson Versatile Wall can more than withstand the devastating forces of hurricanes and tornadoes. Units are designed to expand and contract to take care of building movement and steel framing tolerances without loss of tight seal. Yet infinite design variety is available. Verticals can be made with a variety of sizes and shapes in stainless steel, aluminum, bronze or porcelain enameled metal. Spandrels also can be designed in a great variety of colors and textures.

tightness plus extra design freedom





ROBERTSON V-WINDOWS

Exclusive new side hinged inswinging windows make cleaning easier and safer, and seal positively when locked. There is no interference from pivot pins if hopper is used below, and the entire window can be removed in minutes for easy shop reglazing.

MULLIONS AND SILLS

Great versatility is yours. Trim members can be porcelainized aluminum, stainless, aluminum or bronze. Trim also can vary greatly in depth and surface because of new positive "snap-on" design. A system of weep holes provides positive drainage and ventilation for condensation.

SPANDRELS

Here the designer has infinite choice. The V-Panels are available with a wide variety of surface patterns and can be fabricated in aluminum, bronze, stainless steel, Color Galbestos or vitreous enameled aluminum or steel. *Versatile Wall is as individual as your signature!*

Robertson

Versatile

Wall

Though any type of window can be specified, there are many advantages to the new Robertson V-Window. Hinged at the side, it swings into the room for safer and easier cleaning, plus a more positive seal than possible with a pivoted window. An ingenious hinge allows the window to be removed and replaced with a spare, so that any reglazing can be done in the shop. Moreover, when a hopper window is specified underneath, weight is better distributed on the sill, and it is not necessary to accommodate pivots.

When you design your next curtain-wall building, take advantage of this completely "weather-wise" system which allows so much architectural latitude. Write for literature.

With 150 trained sales engineers and 60 qualified service dealers, Robertson is ready to serve you in any part of the country. You will always have the best of technical assistance when Robertson products are specified.

H. H. Robertson Co.

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NEWS OF ENGINEERS

H. A. Mike Flanakin has resigned as engineering consultant to the managing director of American Trucking Associations, Inc. in Washington, D. C., and has joined the firm of Charles M. Upham Associates, consulting engineers, with headquarters in Bangkok, Thailand. While with ATA, Mr. Flanakin served as special counsel on highway engineering and did much to promote research and development programs that resulted in highway improvement. He has served on the National Advisory Committee for WASHO and AASHO road test projects conducted by the Highway Research Board.

H. A. M. Flanakin

The consulting firm of Weston and Eckenfelder Associates has changed its name to Roy F. Weston, Inc. **W. Wesley Eckenfelder, Jr.,** associate professor of sanitary engineering at Manhattan College and co-founder of the firm, will retain his present status of consulting associate.

Olaf O. Roberts, Jr., has been promoted to assistant general sales manager of the Granco Steel Products Company, St. Louis, Mo. Mr. Roberts has been Granco's product manager for galvanized roof products, and will continue to be responsible for their sale and promotion.

John G. Duba, who formerly taught at the University of Missouri, Northwestern University, and Illinois Institute of Technology, has been appointed administrative officer to the mayor of Chicago. He will supervise administrative management of city departments, boards, and commissions, and coordinate their activities.

John R. Hardin, Major General, USA, (Ret.), and president of the Mississippi River Commission until his retirement in 1957, has been elected president of Engineers of Central America, Inc., a company of consulting engineers operating in the Republic of Panama, Costa Rica, Nicaragua, El Salvador, Honduras, and Guatemala. General Hardin's Washington headquarters are in the Barr Building, 910 17th Street, N.W., Washington 6, D. C.

Max A. Burroughs, structural engineer with Davis & Wilson of Lincoln, Nebr., and **John E. Olsson,** formerly consultant with Fulton & Cramer, consulting engineers of the same city, announce the formation of Olsson & Burroughs, consulting engineers for municipal and structural engineering.

Peter Corradi, Captain, Civil Engineer Corps, has been assigned to the Bureau of Yards and Docks as deputy chief. Captain Corradi has been on active duty with the Corps since 1941. He has been officer in charge of construction at the Portsmouth (N. H.) Navy Yard; executive officer of the 5th Naval Construction Regiment; officer in charge of the 33rd Construction Battalion at Green Islands; public works officer at several bases in the states; and executive assistant to the Assistant Chief for Construction and Real Estate in the Bureau of Yards and Docks.

Peter Corradi

Edo's new Model 400 Stratagraph records strata formations underlying the beds of rivers, lakes and any other relatively shallow body of water, with sharp definition and complete accuracy..

Sediment, intermediate layers, bed rock and faults are all readily distinguished and pictorially shown on the Stratagraph's electrosensitive paper, with an accuracy in depth indication of one-half of one per cent.

The Edo Stratagraph is currently in use in various parts of the world to determine quickly and positively the layers at which foundations can be set. It effects great savings in time and money over older core boring and seismic methods of strata determination.

The Stratagraph's narrow beamwidth is achieved by means of a cone-shaped transducer and results in exceptional depth and layer definition. The Stratagraph makes permanent recordings in eight overlapping range scales:

0-70 feet or fathoms
60-130 feet or fathoms
120-190 feet or fathoms
180-250 feet or fathoms

For complete details write to:

Edo CORPORATION, College Point, L. I., N. Y.

Norman E. Lant, former chief engineer of the Louisiana Department of Highways, has returned to the department temporarily to assist in developing its new highway program. Mr. Lant retired two years ago.

Elson T. Killam, Hydraulic and Sanitary Engineers, announce the formation of Elson T. Killam Associates, Inc., with offices at 48 Essex Street, Millburn, N. J.

Ralph H. Gloss, structural engineer specializing in timber design, has been elected a vice-president of Timber Engineering Company, engineering and research affiliate of the National Lumber Manufacturers Association. Mr. Gloss served as coordinator and editor of the company's "Timber Design and Construction Handbook" which was published in 1956. He will retain the post of secretary, which he has held for the past seven years in the company's Washington, D. C. office.

William N. Carey, who retired as ASCE Executive Secretary in 1955 after ten years in the post, has been elected chairman of the Long Range Planning and Advisory Committee of the City of Vero Beach, Fla. Mr. Carey, a retired colonel in the Corps of Engineers, is now living in Vero Beach.

Harvey F. Ludwig and **Joseph L. Feeney** announce their association under the firm name Ludwig Engineering, with offices at 490 Walnut Street, Pasadena, Calif. They will specialize in sanitary engineering.

Gail A. Hathaway, ASCE Past-President, and engineer consultant to the International Bank for Reconstruction and Development, receives the Army "Exceptional Civilian Service Decoration" from Maj. Gen. E. C. Itschner, Chief of Engineers. Mr. Hathaway was honored for his work as special assistant to the Chief of Engineers.

Charles Sumner Heidel, field representative with the Geological Survey in Montana, has retired from federal service after 47 years of work on state and national water resources. A graduate of the University of Minnesota, Mr. Heidel began his professional career as assistant to the Montana State Engineer, and later himself became state engineer. In 1930, Mr. Heidel joined the Survey, where his primary concern has been with international boundary waters. Long active in the Montana Section, Mr. Heidel in 1955 received the group's Distinguished Service Award for "outstanding professional accomplishment and service to the Society"—the only such award given by the Section.

C. S. Heidel

A. N. Laird, former chief engineer of the Grand Trunk Western Railroad, has been named a partner in the firm of Plumb, Tuckett and Pikarsky, consulting engineers and architects of Gary, Ind. Mr. Laird will have charge of the firm's new office in Detroit, Mich.

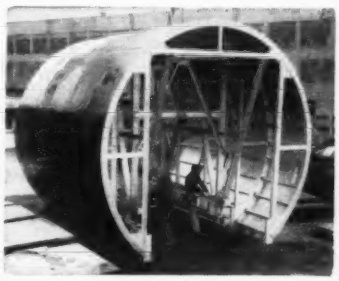
E. P. Sellner has been appointed manager of the Conservation Bureau of the Portland Cement Association, with headquarters in Chicago, Ill. Mr. Sellner joined the association in 1955 as a sanitary engineer in the Bureau. He succeeds **Ezra Wenger,** who is retiring after 24 years of service.

Werner C. Knoop, president of the Eureka Brick & Tile Company of Little Rock, Ark., and co-partner and executive vice-president of the Baldwin Company, general contractors of the same city, is Little Rock's new mayor. Active in public affairs, Mayor Knoop has been a member of the Little Rock Building Code Committee since 1946 and has served on the Building Code Board of Appeals.

Sigvald W. Steffensen, deputy director of the Division of Sewage Disposal of the New York City Department of Public Works, has been named Queens borough consulting engineer. Mr. Steffensen, a career civil service engineer, will direct and supervise the work of the sewer and highway design and construction bureaus at Borough Hall.

James S. Sweet has returned to his duties in the U.S. Weather Bureau, Washington, D. C. after a year as consulting hydrologic engineer to the Colombian government at Bogota.

George Langsner has been transferred to the Sacramento headquarters of the California Division of Highways as engineer of design. His most recent assignment was as district engineer in charge of planning, at Los Angeles.



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Mayo produces all types of Tunnel Forms—telescopic, non-telescopic, separate sidewall and arch, single unit, full round forms for monolithic pours, etc. Each is designed for the exact requirements of the job in any part of the world—be it tunnel, sewer or conduit.

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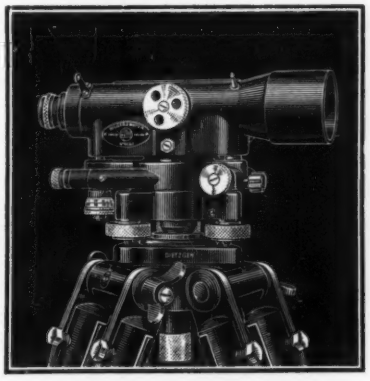
LANCASTER, PENNA.



PROVEN IN THE FIELD . . . WHERE PERFORMANCE COUNTS

Watts Microptic Engineers' Levels are tops with foremost construction engineers throughout the country. Here is precision performance, time-saving performance, dependable performance in all climates and terrain. For full information on the complete line of Watts Microptic Engineers' Levels see your nearby Dietzgen Dealer. Made by Hilger & Watts, Ltd., London, sold and serviced in the United States by the Eugene Dietzgen Co.

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DIETZGEN

C. A. McTaggart, northwestern division manager for Armco Drainage & Metal Products, Inc., has been elected a vice-president of the company. Mr. McTaggart's service with Armco dates from 1926, when he became associated with the Armco Culvert Manufacturer's Association. In later years he was assistant manager of the Sioux Falls Metal Culvert Company, which became part of Armco.

C. A. McTaggart

Frederick J. Sanger has left Worcester Polytechnic Institute, where he was professor of civil engineering, to work for the Corps of Engineers. Mr. Sanger is serving as a special assistant in the Foundation and Materials Branch and Arctic Construction and Frost Effects Laboratory of the New England Engineer Division.

W. G. Huber has resigned after three years as general manager of the B. C. Engineering Company Limited, Vancouver, B. C. He will remain in Vancouver to practice as a consultant on heavy construction for the B. C. Engineering Company and other clients.

The firm of **Herbert L. Kartiganer,** Consulting Engineers and Designers, announces the opening of an office offering complete service on residential, commercial, and industrial engineering, design, and landscape architectural problems. The firm's offices are located at 75 Second Street, Newburgh, N. Y.

Steven Galezeweski, formerly project engineer with Rockwin Prestressed Concrete Corporation, has assumed duties as senior engineer of structures in the Missile Division of Holmes & Narver, Inc., Los Angeles, Calif.

Henry F. LeMieux, assistant vice-president in charge of sales for the Raymond Concrete Pile Company's southern region and New Orleans district manager, has been transferred to the company's New York office, where he will be in the sales department. **Eugene F. Gibbons** has been appointed district manager of the company's Philadelphia office. He was formerly project manager on the construction of foundations and approaches for the Second Narrows Bridge in Vancouver, B. C.

Frank George George, architect of Sanford, Fla., announces that he is moving his office to Palatka, Fla. His address there will be 119 North 4th Street.

Thomas M. Sullivan, chief of the Aviation Planning Division of the Port of New York Authority, has been awarded the bi-state agency's Distinguished Service Medal. The award, the Port Authority's highest recognition of meritorious service, was given Mr. Sullivan for his role in planning the $150,000,000 Terminal City at New York International Airport. Presentation of the award took place at the recent dedication of the Terminal City Project.

T. M. Sullivan

Gibbs & Hill, Inc., consulting engineers of New York City, have promoted **John B. Saxe** and **Boris Lochak.** Mr. Saxe, chief engineer since 1953, has been appointed chief consulting engineer, and will continue to serve as a vice-president and director. Mr. Lochak, a director of the firm, has just been named chief engineer and a vice-president.

Patricia Ann Flynn, associate engineer with the Seattle Engineering Department, and one of three women registered as a professional engineer in Washington, has been named a "Woman of Achievement" by the Past Presidents' Assembly (a Seattle club group). Miss Flynn was graduated from the University of Washington in 1951.

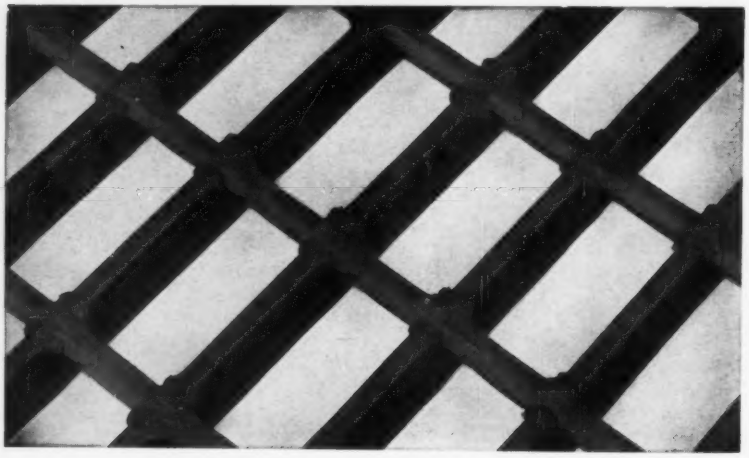
John B. Boyanchek, structural design engineer and consultant with the Alaska Department of Commerce, has been appointed sanitary engineer on the staff of the Alaska Department of Health Sanitation and Engineering. Mr. Boyanchek is chief of the plan review unit, with headquarters in Juneau.

Joseph C. Webber, former assistant commissioner of engineering for the city of Toledo, Ohio, has been appointed senior engineer in charge of the highway and pavement division of Finkbeiner, Pettis & Strout, consulting engineers of Toledo.

Edward J. Costello, Jr., head of the sales department of the Wiley Manufacturing Company at Port Deposit, Md., has been named vice-president in charge of sales. The new vice-president, an experienced technical engineer, consultant and administrator, has been with the firm since 1954. Prior to his association with the Wiley Manufacturing Company, Mr. Costello headed his own consulting office in Washington, D. C.

E. J. Costello, Jr.

(Continued on page 112)



Hexagonal Cross Bars...Resistance Welding make

Gary WELDED GRATING safer, stronger neat appearing

One piece construction with tops of all bars flush provides safer, longer-lasting open steel flooring. And it's tailor-made to fit your requirements. For typical installations and full details on Gary gratings, stair treads and decking, write for Catalog CE-28

FREE SAMPLE
We'll send this handy paper weight if you request it on your company stationery.

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GARY GRATING DIVISION
4000 EAST SEVENTH AVE., GARY, INDIANA

OFFICE BUILDING

WALTHAM, MASSACHUSETTS

AWARD WINNER- *1957 Grand Award, New England District, A.I.A.*

Structural steel framing was chosen to suit the light, free quality of space desired in this office building for Boston Manufacturers and Mutual Boiler & Machinery Insurance Companies. A careful analysis of the cost of steel compared with other structural systems, and an anticipated reduction in construction time helped the architects to reach a decision in favor of this material. They were able to give the clients the spans which best answered the space requirements, with a minimum of lost floor area due to columns.

Fireproofing of horizontal members was accomplished economically by the use of a fire-resistant mineral barrier as a mounting surface for the acoustic tile ceiling.

Anderson Beckwith and Haible, Boston, Mass.

General Contractor:
Turner Construction Co.

Structural Engineer:
Cleverdon, Varney & Pike

Steel Fabricator:
Groisser & Shlager Iron Works

Steel Erector:
Owen J. McGarrahan

Structural Shapes:
Bethlehem Steel Company

A SIGNIFICANT NEW STRUCTURE . . . FRAMED WITH STEEL

This is the fourth in a series by Bethlehem Steel Company, Bethlehem, Pa.

BETHLEHEM STEEL

Why a TD-24 'dozes full blades *where other rigs spin and*

You don't have to jockey around, or settle for "shirt-tail" loads, or get only part-capacity performance, when you concentrate the International TD-24's full rock-slamming power—right where you want it!

You don't waste time, and fuel, and tractor life with rear-end "sluing." You don't have to "paw dirt" and then wind-up "nibbling," instead of blading out full bites. You don't lose momentum and let the blade lose part of the load every time you steer. Not with TD-24 "follow-through"!

Exclusive International Planet Power steering makes the big difference.

"Dead-track drag" is eliminated

You don't "half-kill" your power and traction to guide the TD-24, as you must with any king-size steering clutch tractor. Instead, Planet Power steering gives you full-time "live" power on both tracks while turning—or while "equalizing" to steer accurately with offset loads. And the TD-24 handles the same big loads on turns or straightaways!

Besides, the TD-24 gives you cycle-speeding, on-the-go Hi-Lo shifting. You adjust speed to the load without stopping, going forward or in reverse. You speed up the shuttle-dozing cycle, take full-time advantage of the TD-24's full capacity!

The fingers of one hand control these TD-24 performance exclusives!

Watch a TD-24 perform—see why rock-movers call it the "rock-dozing special." Visualize how this load-control and bonus capacity make the TD-24 the ideal pusher, or outstanding for non-stop, big scraper pulling! See your International Construction Equipment Distributor for a demonstration.

Put one track in high range, the other in low—and the TD-24 pushes straight ahead, despite the tremendous offset load of benching-out unshot rock strata. P. C. Cooper, Blountsville, Tennessee, first rented this TD-24—then bought it because of its rock-'dozing performance!

An 8-unit TD-24 fleet owned by Rusciano and Sons Corp., replaced 8 big competitive crawlers—because TD-24 performance "measured up" to the toughness of this big road job. There was a considerable tonnage of granite and other rock to bulldoze—on the White Plains (N.Y.) Section of the 'Cross Westchester Expressway!

"With the TD-24, I can outwork any other machine where you have to push and turn with a big load," declares Operator Dan Olmstead, for Gibbons & Reed, Salt Lake City, Utah. "The TD-24 keeps the load moving, because you don't lose power braking a track." The TD-24 is spreading rock on a tough million-yard project—widening U. S. 40 in the Truckee River canyon near Reno.

# of rock *stall!*

International® Construction Equipment

International Harvester Co., 180 N. Michigan Avenue, Chicago 1, Illinois

A COMPLETE POWER PACKAGE: Crawler and Wheel Tractors . . . Self-Propelled Scrapers . . . Crawler and Rubber-Tired Loaders . . . Off-Highway Haulers . . . Diesel and Carbureted Engines . . . Motor Trucks . . . Farm Tractors and Equipment.

Cellular wharf and bulkhead

▲ **Straight web piling** used for cellular wharf construction to assure maximum strength in tension.

FREE!
56-page book on Steel Sheet Piling covers application information on all types of sheet piling. Write to United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa.
USS

built tight and strong with USS Steel Sheet Piling

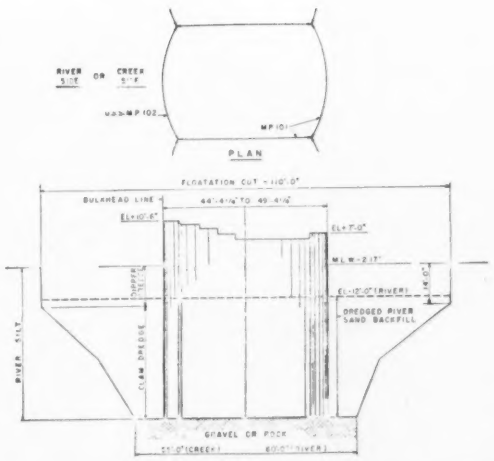
THE NEW EDDYSTONE STATION of the Philadelphia Electric Company will contain two 325,000-kw electric generating units. The No. 1 unit is designed for 5000 psi, 1200° F. steam conditions and will be the world's largest and most efficient turbo-generator. The No. 2 unit will operate at 3500 psi and 1050° F.

Construction involved a 900-foot cellular wharf along the Delaware River and a 1400-foot bulkhead wall along Crum Creek. The cellular wharf required 1932 straight web piles for the first 800 feet. Silt was excavated to gravel strata (on rock) for a trough 10 feet wider than cells at base, and the trough was backfilled with river sand prior to driving.

The bulkhead was built with 1004 Z-type piles. Driving was tough. Numerous boulders in the gravel strata required extensive jetting during driving. Piles were 30 to 60 feet long and were driven to rock.

When you need any type of piling—straight web, arch web or Z-type sheet piling, or H-beam bearing piling—get in touch with the United States Steel office near you.

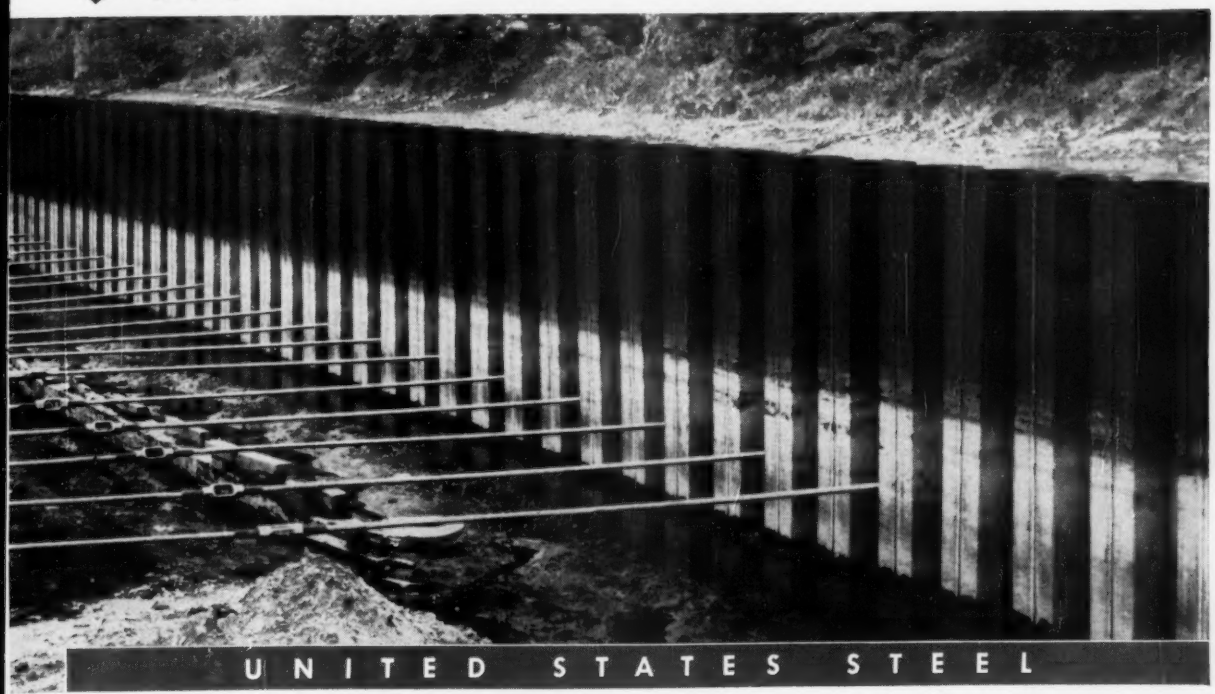
The general contractor for the Eddystone Station job is United Engineers & Constructors, Inc.; pile-driving contractor: Thomas Earle & Sons.

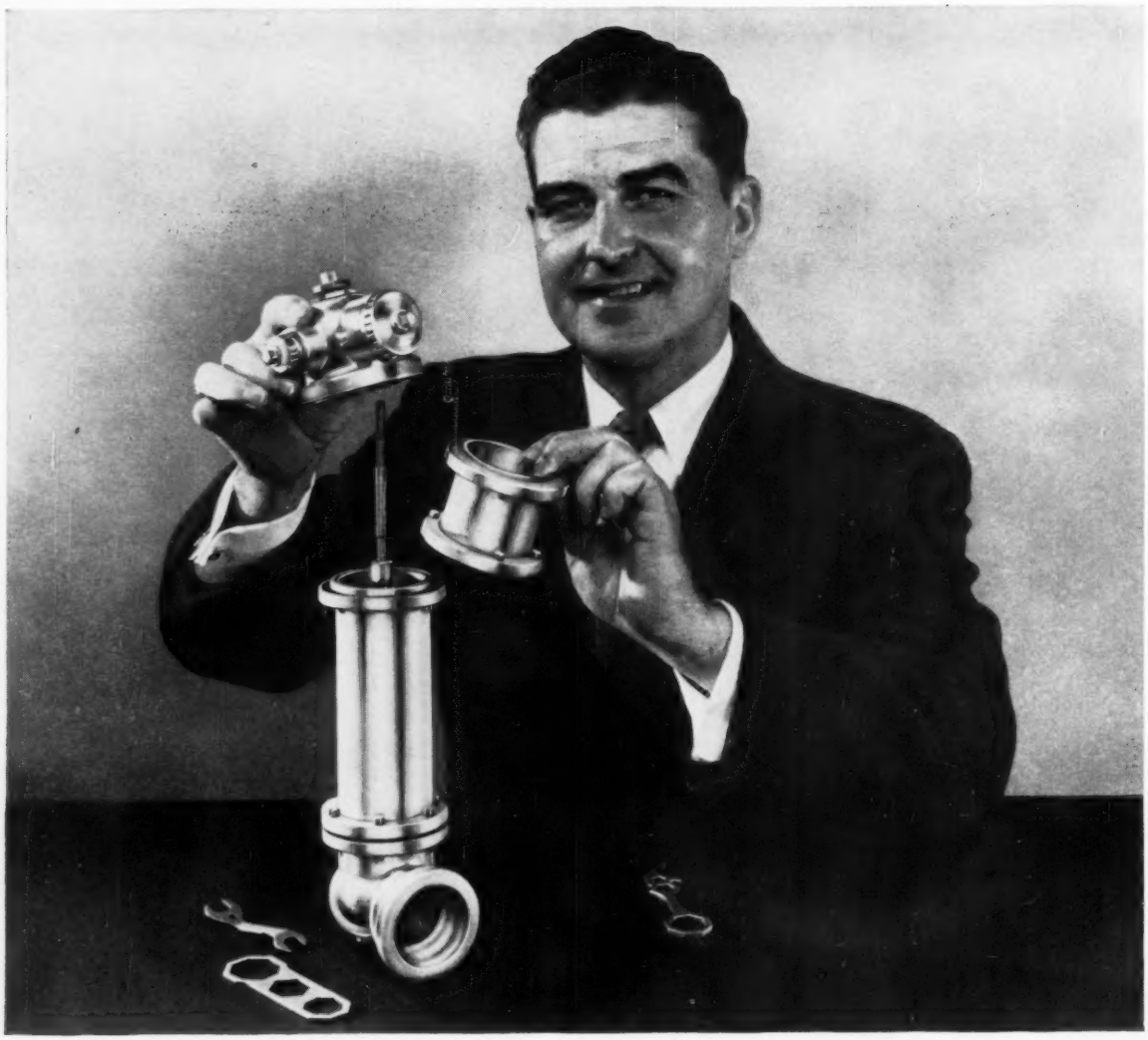


Cellular wharf construction using standard USS MP-101 or MP-102 piling with "Y" piece in the corners.

United States Steel Corporation, Pittsburgh, Pa.
Columbia-Geneva Steel Division, San Francisco
Tennessee Coal & Iron Division, Fairfield, Ala.
United States Steel Export Company, New York

Z-type piling used for permanent bulkhead wall for maximum beam strength and economy.





You'll see a demonstration of the completely revolving head. The entire head or nozzle section can be faced in any direction with none of the restrictions imposed by ordinary flanges. All that is necessary is to loosen the bolts in the flange.

We'll be glad to show you the R. D. Wood Swivel Joint Hydrant right in your office

We'll show you the optional breakable flange and stem coupling which permit quick repair and thus give the community better fire protection—and you won't have to get out of your office chair!

We mean a scale working model, of course, about 2 feet high and accurate down to the last nut and bolt. As we take it apart for you, you will see quite clearly the hydrant's sound, simple construction, the smoothly rounded changes in diameter which reduce friction and deliver water at full pressure.

It's a really reliable hydrant. Like to see it? Write us today for a demonstration.

R. D. WOOD COMPANY

Public Ledger Building, Philadelphia 5, Pa.

Manufacturers of "Sand-Spun" Pipe (centrifugally cast in sand molds) and R. D. Wood Gate Valves

. . . . . *Am-Soc Briefs*

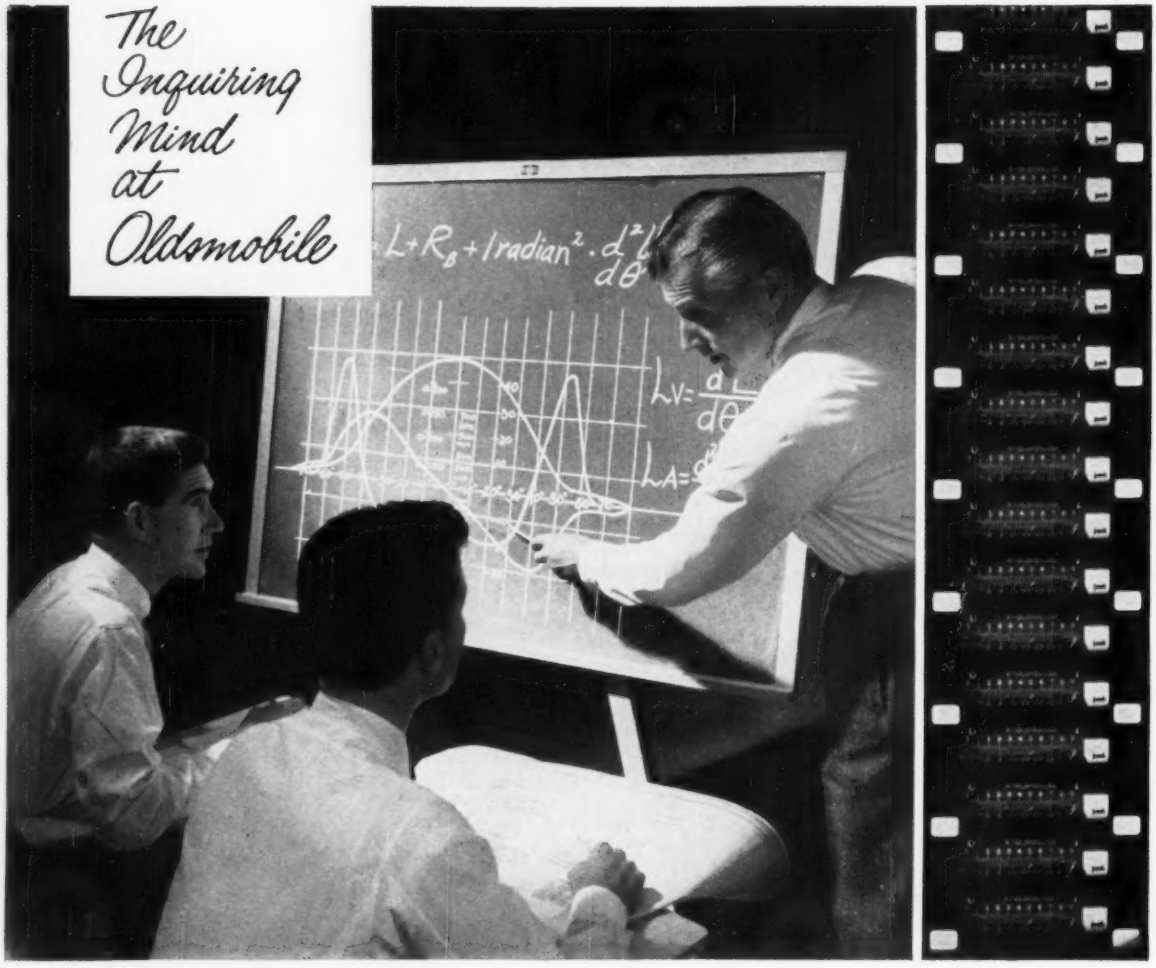
▶ ▶ Do you find yourself concerned by reports on the status of our professional education? Long before Sputnik, the Society recognized the need for a study of engineering and scientific curricula and appointed a Task Committee on Professional Education to make such a survey. The results of the committee's thoughtful four-year study -- reported at the Annual Convention last fall -- are published for the first time in this issue (page 61). . . . The Board of Direction will appreciate the comment of members on the report.

▶ ▶ How young people themselves look upon engineering as a career and current employment conditions are topics for two provocative Conditions of Practice sessions set for the forthcoming (February 24-28) Chicago Convention. The rich Chicago technical program, which will have some sessions with the American Concrete Institute, meeting in Chicago concurrently, was published in the January issue. . . . Speaking of Conventions, vacation-land settings are promised those deciding to attend the Portland Convention (June 23-27) and the Hawaii Section's Post-Convention Tour of the Islands. The tour will take off from Portland by air on June 29 and will include technical sessions in Honolulu on July 1 and 2.

▶ ▶ More about the United Engineering Center. . . . With the fund-raising campaign just getting under way, industry has already contributed over $1,500,000. Two $300,000 contributions and two of $200,000 top the impressive list of donations. . . . UET President Walter J. Barrett calls the Center ''the largest and most important single project ever to be undertaken by the organized engineering profession.''

▶ ▶ Last call for Membership Directory data. . . . This is a final reminder that data for the new ASCE Membership Directory are due by March 15. For the convenience of members having job or address changes to report we are repeating the coupon (page 130) that appeared in the December and January issues. . . . Later in the spring members will be asked to say whether or not they want a copy of the Directory -- to guide us in determining the size of the edition.

▶ ▶ Still on the subject of publications. . . . Last May the Air Transport Division sponsored a Jet Age Conference devoted to the increasingly significant question, ''How can the civil engineer provide efficient and economic terminals to handle jet age traffic?'' The conference papers were published as the December issue of the Air Transport Journal, which has been mailed to members enrolled in the Division. Others may want to buy copies at $3.00 each. . . . The Public Relations Department at Headquarters has issued the first of a series of bulletins to help Sections and Branches in their public relations work. A new ''Public Relations Guide'' will be out soon.



no.1 OF A SERIES

FORMULA FOR A NEW BABY OF OURS

High speed photography helps Oldsmobile engineers translate the theory of camshaft design into practical reality.

Developing the "brains" of an engine—its camshaft—demands engineering skill of a high order, both in theory *and* practice. Advanced techniques of precision measurement guide Oldsmobile engineers in creating a profile design of optimum efficiency.

To determine exactly what happens in a valve train system, movies are taken at speeds up to 15,000 frames per second. The valve train under study is assembled in an engine block and driven by an electric dynamometer at precisely controlled speeds. A vernier scale, silver soldered to the valve spring retainer, is photographed as it moves with the valve's opening and closing.

Essentially, these photographs act as an analog computer. Analysis gives a plot of the actual "lift curve" of the camshaft—the exact linear movement of the valve at each degree of camshaft rotation. It tells at what points the valve opens and closes and also whether the valve lifter is following the cam as it should. This curve, compared to the theoretical lift curve is a definite point for refining to begin—to make sure that design theory will be production practice. With this exact and rapid technique of analysis, as many as 50 experimental camshafts may be tested before a final design is fixed.

The Inquiring Mind at Oldsmobile is never at rest in its attempt to build the best engineered car in the industry. Test drive the '58 Oldsmobile and you'll find it's the finest product in our 60-year history.

OLDSMOBILE DIVISION, GENERAL MOTORS CORP.

OLDSMOBILE

Pioneer in Progressive Engineering ...Famous for Quality Manufacturing

do you know that

Construction is expected to bolster the sagging economy in 1958? As government and other experts see it, construction outlays will rise 5 percent to $49 billion. Prices will account for half the increase, meaning there will be physical gains, too. There will be no lack of materials to hamper activity.

• • •

Plastics are now basic building materials? Ranking fourth as a building material (behind steel, lumber, and glass), they are used at an annual rate of $1,200,000,000. The number one application is paint, which will take about 90,000,000 lb of plastics this year. Almost equal amounts will be required for coating wire and bonding plywood. This is an estimate of the American Chemical Society.

• • •

Engineering student registration is at an all-time high? In the face of arguments as to whether the supply of engineers is catching up with the demand, last fall's enrollment represented an increase of more than 20,000 over the previous year. According to U. S. Office of Education estimates, undergraduate registration (in September 1957) was up 17,500 over the previous fall. Electrical engineers headed last June's list of graduating students with 8,108. Mechanicals were next with 7,907, and civils third with 4,683.

• • •

The energy released in a single hurricane equals the entire output of electrical energy produced in the United States in a generation? This was one of the dramatic disclosures at the Council on Wave Research's recent Sixth International Conference on Coastal Engineering held at the University of Florida. Originally a project of the ASCE Hydraulics Division, the Council on Wave Research was set up under Engineering Foundation in 1950.

• • •

The steel industry is operating at 78 percent of capacity? A year ago the operating rate was 96 percent of capacity. A drop in shipments and drastic inventory cutting are held largely responsible for the slump in operating rate. However, the dramatic expansion in steel capacity since World War II means that production continued high in 1957 (some 113 million tons) despite the decline in operating rate.

Roadbuilding throughout the Free World increased in 1957? Continuing a ten-year trend, the 1957 figure was a record $15.032 billion, a 16.5 percent jump from 1956. The U. S. continued to be highway leader, with expenditures of $9.1 billion (up from $7.9 billion in 1956) and a network of 3,418,000 miles. Canada continued in second place with expenditures of $885 million, up from $725 million in 1956. Running a close third was West Germany with highway outlays of more than $883 million, an increase of $313 million over 1956. Japan, incidentally, is planning a $5 billion, ten-year road program. Source for this is the International Road Federation.

• • •

Construction of the St. Lawrence Seaway stands at the three-quarter mark? With fifteen months remaining until the scheduled completion date in the spring of 1959, the St. Lawrence Seaway Authority announces that the mighty billion-dollar project is about 75 percent done. In the 400-mile stretch from Montreal to the Welland Ship Canal on Lake Erie, the Authority has awarded 125 contracts, with a value of some $235,000,000, and 29 of them are completed.

• • •

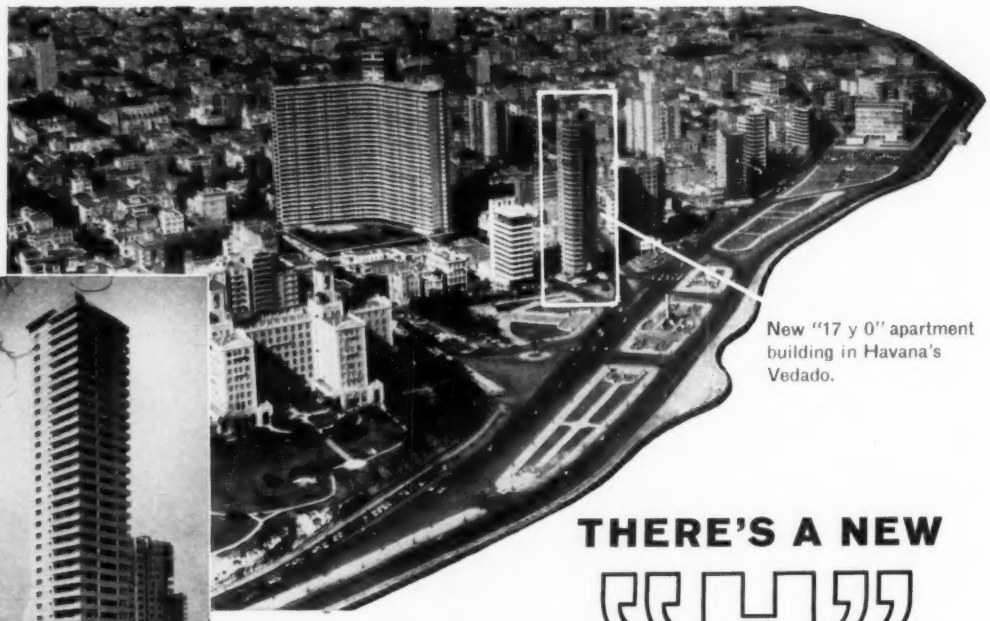
Sewage treatment facilities now serve 86 out of every 100 people in the Ohio River Valley? This represents a long stride forward in pollution control since 1948 when the Ohio River Valley Water Sanitation Commission was formed. As an indication of what such groups can do, existing purification works in that year were serving less than one out of every 100 people. This is one of the highlights of the Commission's annual report, available from the headquarters of the Commission at 414 Walnut Street, Cincinnati 2, Ohio.

• • •

The "Atoms for Peace" program is in full swing? During 1957 the U. S. atomic industry completed the construction of sixteen nuclear reactors—seven of them power-type reactors and nine of them research and test units for private and government markets here and abroad. In addition, industry continued or began the construction of 59 reactors—35 of them power-type units and the others research and test reactors.

• • •

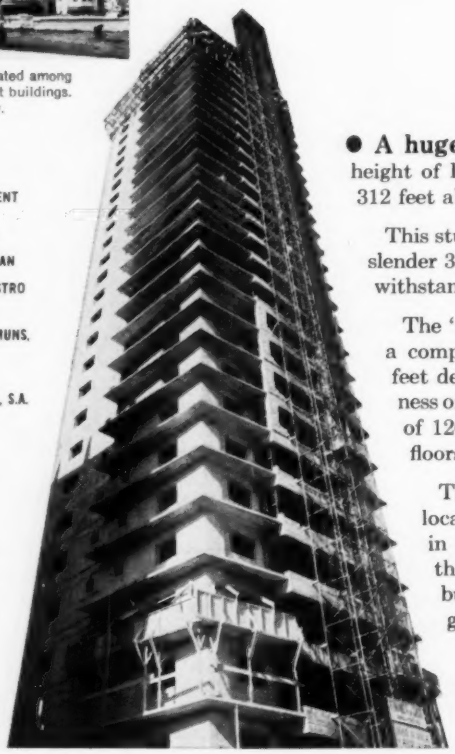
The world's highest dam is in operation? It is the 780-ft-high Mauvoisin Dam in southwest Switzerland, which was dedicated in the late fall. The arch-type structure is 1,760 ft long and contains 2.8 million cu yd of concrete. It is a hydro-power project.



New "17 y 0" apartment building in Havana's Vedado.

Completed building seen above, situated among other new apartment and government buildings. (At right) dramatic construction view.

THERE'S A NEW "H" IN HAVANA



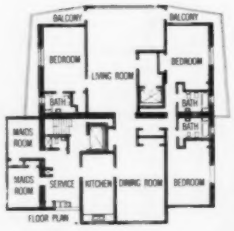
"17 y 0" COOPERATIVE APARTMENT BUILDING
Vedado, Havana, Cuba

Owner: **GUILLERMO SOMEILLAN**

Architect: **FERNANDO R. de CASTRO**

Engineers:
J. A. VILA, B. DESCHAPELLES, A. MUNS, R. GUTIÉRREZ

Contractor:
CONSTRUCTORA METROPOLITANA, S.A.



Huge reinforced concrete "H" beam forms the backbone of the structure.

● **A huge "H" beam** extends upward the entire height of Havana's newest luxury apartment building, 312 feet above sidewalk level.

This sturdy diaphragm forms the "backbone" of the slender 32-story structure and is carefully designed to withstand wind stresses due to hurricanes.

The "H" beam is built of reinforced concrete with a compressive strength of 5000 psi. Measuring 55 feet deep, with 60-ft. flanges and a variable thickness of web, it is constructed to resist wind pressures of 120 mph at lower levels to 180 mph on upper floors.

The building, known as "17 y 0"—its street location—towers above historic Malecón Drive in the famous Vedado section. It exemplifies the dramatic beauty of the many new modern buildings designed in concrete along Havana's growing skyline.

A total of 11,000 bbls. of El Morro Cement, produced by La Compañia Cubana de Cemento Portland, Lone Star subsidiary, were used in the project.

LONE STAR CEMENTS COVER THE ENTIRE CONSTRUCTION FIELD

LONE STAR CEMENT CORPORATION

Offices: ABILENE, TEX. • ALBANY, N.Y. • BETHLEHEM, PA. BIRMINGHAM • BOSTON • CHICAGO • DALLAS • HOUSTON INDIANAPOLIS • KANSAS CITY, MO. • LAKE CHARLES, LA. • NEW ORLEANS NEW YORK • NORFOLK • RICHMOND • SEATTLE • WASHINGTON, D. C.

LONE STAR CEMENT, WITH ITS SUBSIDIARIES, IS ONE OF THE WORLD'S LARGEST CEMENT PRODUCERS: 21 MODERN MILLS, 48,900,000 BARRELS ANNUAL CAPACITY

CIVIL ENGINEERING

Miracles . . . just ahead

G. BROOKS EARNEST, M. ASCE, President, Fenn College, Cleveland, Ohio

It may be that the human race is a miracle. At least we have fathomed only a little of its mystery. We understand a good deal about the relation of man to nature. In the relations of man to man and man to God, however, our advances since Biblical times are unimpressive.

Because of what man has learned of nature, he is now the supreme animal on earth. He would do well to remember that before man and the great mammals came the great lizards, who perished. Perhaps the real miracle is that man has come so far in so short a time and has not yet perished.

His numbers, right now, are rapidly increasing. He must have new sources of food to maintain himself. Science is on the way to providing a sufficiency. The discovery of hybrid corn will be followed by others equally beneficial. Agricultural research has greatly advanced through the use of radioactive "tagged" atoms and other atomic techniques so that farms will be many times more productive. Man will draw vast stores of food from the sea. Synthetic foods out of presently inedible organic matter will come through control of photosynthesis.

Before this, however, many inhabitants of our planet may face a critical shortage of water. The usable water on earth is already in short supply, yet human beings—especially in the United States—still indulge in traditional extravagance. They waste water through pollution and reckless destruction of moisture-containing ground cover such as trees and grass. Civil engineers the world over are learning to conserve what man has; they will recover much that has been lost, as in the valley of the Jordan River, and they will establish whole new regions of watered fertility. They will treat river systems as balanced economic resources for water supply, power, navigation, and fertility. They will recharge ground waters with flood waters and reclaimed sewage. They will find an efficient and inexpensive method of turning salt water into fresh that will open many areas to human habitation.

Man is exploiting new sources of energy in the atom and in sunlight to such effect that energy may become as available as water and air. The heat pump is at work heating and cooling buildings. Solar energy has already been directly converted to electrical energy with a silicon reactor. The gas turbine for automobiles is here; its practical use is around the corner. And all these developments are but the gropings of amateurs compared to what experts will consider commonplace in the future. No sooner is a new stride forward predicted, such as the space satellite, than it is here.

Accurate distance-measuring media through the tellurometer and the geodimeter will hasten the operations of expansive control surveys. Research is continuous on the photogrammetric production of maps. In the field of transportation, lightweight but structurally stable freight cars are now under construction, allowing for greater pay loads per unit of motive power.

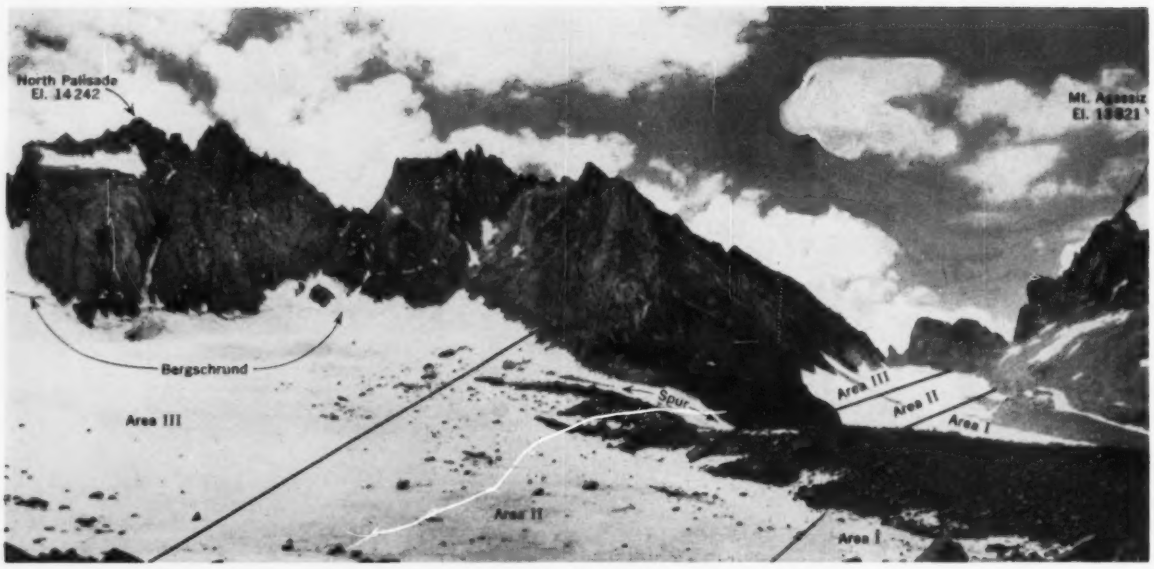
Other engineering phenomena to come include separate highways for trucks and automobiles in areas of heavy metropolitan congestion, fool-proof safety controls for high-speed traffic, and transportation of mail and freight over vast distances by guided rockets. We will be able to drive from coast to coast without encountering a traffic light, a tourist's dream. Multi-decked bridges and tunnels will join water-divided land areas with unheard-of spans and bores. Their planning and construction will depend on the new scientific discoveries in soil mechanics. The analysis of soils and core-boring data at the site have eliminated guesswork in the construction of all foundation-supported structures—and roads as well. On construction projects helicopters will be as common as trucks today. Almost anything can happen.

What emerges, though, is that civil engineering will be one of the essential tools fashioning this future. Its scope and content will be greatly extended. The capacity of the individual scientist and engineer to comprehend its meaning will be more severely challenged. The engineer's education is of critical importance.

Yet the great beneficent projects civil engineering can accomplish, such as control of vast river systems or shrinking distances on land, on the seas, and in the air, depend upon the cooperation of nations and peoples.

So we come to the most important miracle of all, the Biblical kind. Without a moral, intellectual and spiritual development comparable to our scientific progress, science and technology could become malignant weapons annihilating the race. Everybody agrees on the danger, but what miracle of the Biblical kind should we wish for?

I like to think there is in man himself a spark of genius communing with God, never quite extinguished in any of us. It could light a steady flame of moral, intellectual and spiritual revolution in each of us. We can find ways of lifting ourselves from our own violences even as we lifted ourselves from the violence of nature. We can change our minds and hearts if only we will try. And we must really try—quickly. Science itself works for this miraculous change in the minds and hearts of men that they may know their brotherhood, use their freedom, and seek the good.



Sierra Nevada glacier measured

FRED A. CAMP, A.M. ASCE
Design Engineer, Los Angeles Department of Water and Power, Los Angeles, Calif.

Water resources in the snow covered Sierra Nevada are an important source of supply for California cities. To Los Angeles especially, the eastern slope of the Central Sierra Nevada, draining into the Owens River-Los Angeles Aqueduct in Inyo County, is exceedingly important.

Over a period of 16 years it has been my pleasure to study and observe in the field many features of the 1,342 square miles of watershed of the Los Angeles Department of Water and Power. Palisade Glacier, the largest and probably the deepest in the Central Sierra at this latitude (37° N), is located 27 miles west of Big Pine in Inyo County. It is one of 19 glaciers on the Department's watershed. It lies at a mean elevation of 12,700 ft on the northerly slope of a magnificent amphitheater subtended by lofty peaks which include Temple Crag (12,999), Mt. Gayley (13,510), Mt. Sill (14,162), North Palisade (14,242), Thunderbolt Peak (13,850), Mt. Winchell (13,768) and Mt. Agassiz (13,821). See Fig. 1.

The highest peak in the United States, Mt. Whitney (14,502), lies 35 air-line miles directly south of Palisade Glacier, and Death Valley, the lowest and hottest spot in the United States (El.—282), lies 125 air-line miles to the southeast.

On a two-day knapsack trip to Palisade Glacier during July of 1955, I made the observations and field survey from which the map and sections in Fig. 1 have been drawn. These data constitute a contribution to the International Geophysical Year (IGY).

The cirque glacier is not a remnant of the Ice Age. It is the product of the "Little Ice Age" formed after the "Climatic Optimum." Its approximate age of 4,000 years was determined in 1912 when calculations were made of the total amount of salt that was then contained in the modern Owens Lake, and of the quantities of salt which Owens River was bringing in annually.

The four lateral moraines, about 120 ft high, were found to be about as regular as any man-made embankment. Between them lies a magnificent ice field of about 2 sq miles. The upper part, protected from the sun, is covered with grayish snow studded with rocks. The lower part, more exposed to the sun, revealed broad, ribbon-like bands of blue-green ice and surface water. Near the snout of the east section is a two-acre pond in which floated white-capped blue-green icebergs. From the pond a measured 26 cfs of water flowed to form the North Fork of Big Pine Creek, a tributary of Owens River.

Previous measurements of the recession of the glacier were made by Kehrlein in 1925, 1933, and 1946. My slope measurements of the glacier were made with a 125-ft rappel rope marked off at 10-ft intervals, and with a 6-ft steel tape. The surface elevation of the lateral moraines at the same location was obtained by interpolation between the contours of an enlarged topographic map of the glacier.

As noted on Section B-B of Fig. 1, the recession from 1925 to 1955 is 83 ft. This means, according to approximate computations, a loss of 65,000 acre-ft of névé and glacial ice—a grim reminder of much loss of water potential.

Small as present-day Sierran glaciers go, 4,000-year-old Palisade Glacier is characterized as the largest and deepest in the Central Sierra Nevada at this latitude. In the past thirty years it has receded 83 ft, losing 65,000 acre-ft of névé and glacial ice in the process. This composite view was taken from El. 12,800.

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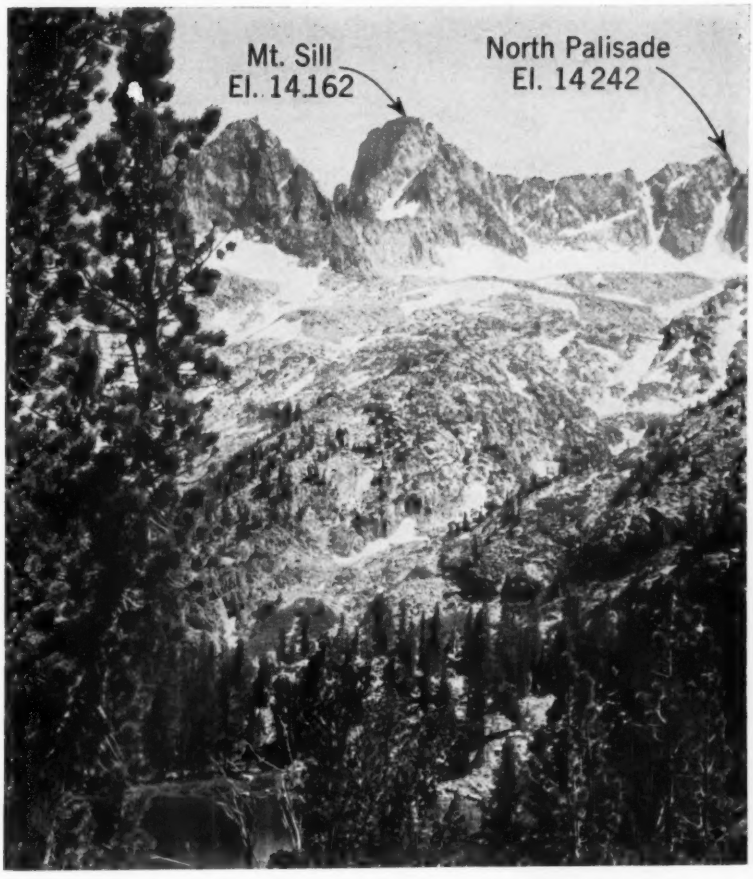
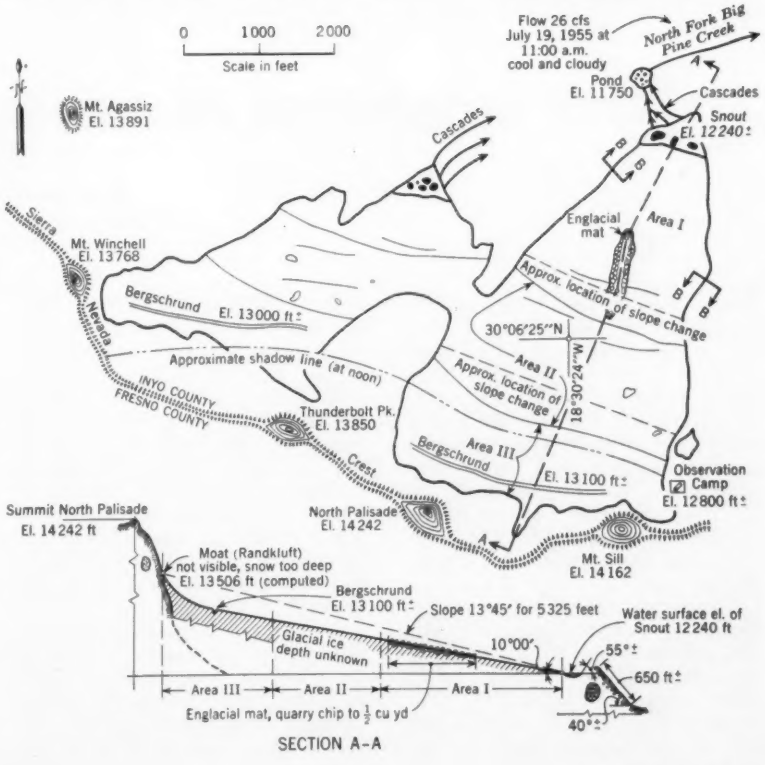


Palisade Glacier, at El. 12,700, is one of 19 existing glaciers on the 1,342-sq mile watershed of the Owens River-Los Angeles Aqueduct. This view was taken from El. 11,000, looking south toward 14,000-ft crest of Central Sierra Nevada in Inyo County, California. From it flows North Fork of Big Pine Creek, one of many sources of water supply for the aqueduct.



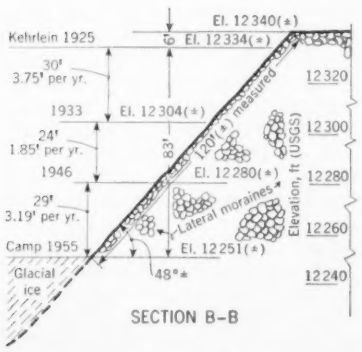
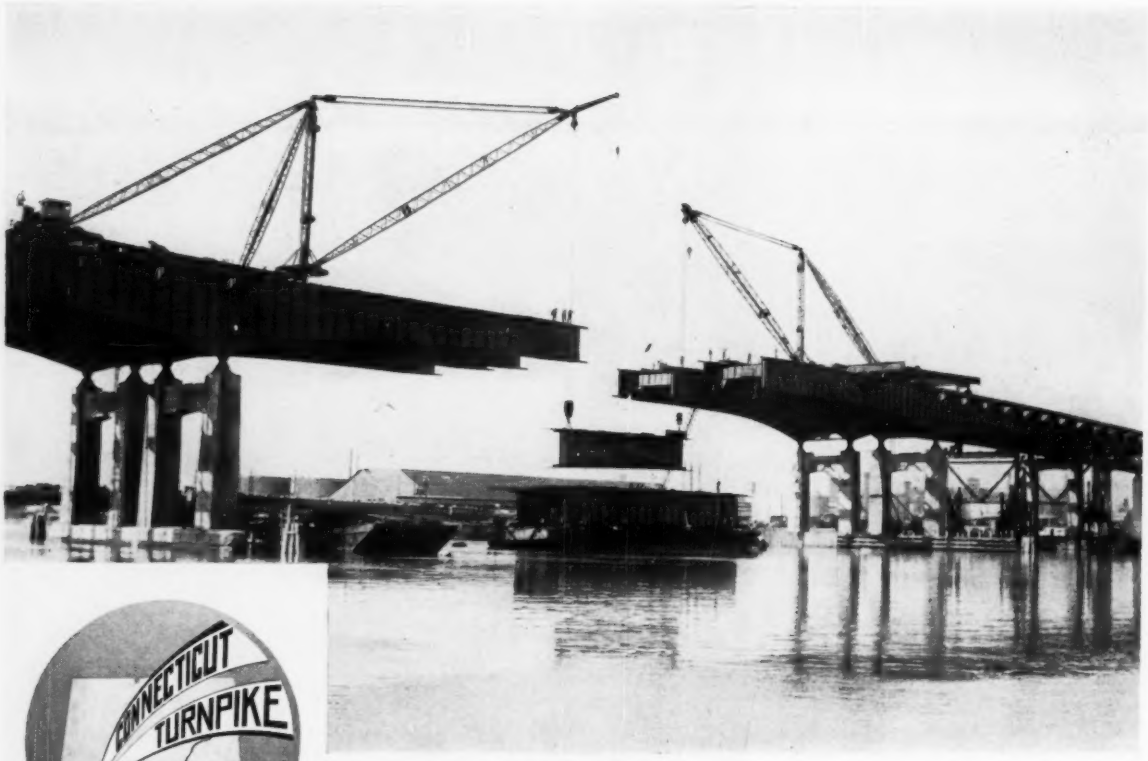


FIG. 1. Palisade Glacier lies in an amphitheater wedged between the great walls of the Central Sierra Nevada peaks. Cross sections show structure in 1955 and ice losses from 1925 to 1955. Approximate densities of various parts of glacier, estimated in the field, are: fine granular settling snow, 0.10; old firn snow, moderately wet, 0.35; old firn snow, very wet, 0.45; névé or firn ice, 0.60; glacial ice, 0.85.



Traveling derricks set 108-ft length of closing steel in 387-ft record-breaking plate-girder span. This structure over Quinnipiac River carries six lanes of Turnpike traffic.

LONGEST PLATE-GIRDER SPAN in Western

R. M. BOYNTON, Associate Engineer with D. B. Steinman,

The Quinnipiac River Bridge at New Haven, with its central three-span continuous plate-girder unit, is the largest structure on the 129-mile half-billion dollar Connecticut Turnpike. Its span lengths are 258, 387 and 258 ft, the center span being the longest for this type of construction in the Western Hemisphere. The previous record of 375 ft was held jointly by two bridges on the New Jersey Turnpike, those over the Hackensack and Passaic Rivers.

The record-breaking span crosses the Quinnipiac River at its confluence with the Mill River only 375 ft upstream from the existing Tomlinson Bridge which carries the Boston Post Road, Route U.S. 1. The waterway is only 125 ft wide between fenders at the Tomlinson Bridge, beyond which there is a sharp turn to the right for boats going up the Quinnipiac and an even sharper turn to the left for those going up the Mill River. Provision for safe navigation through this funnel required the span length of 387 ft for the Quinnipiac Bridge. Additional dredging was required at the head of the "Y" formed by the two rivers. This provided a turning basin and obviated the need for an even longer and more expensive bridge at this crossing.

The major structure over the Quinnipiac River, carrying the six lanes of Turnpike traffic, is nine-tenths of a mile long. This includes the record-breaking three-span continuous unit 903 ft long; 2,541 ft of simple-span girders varying from 125 to 175 ft in span length; and 1,290 ft of simple-beam spans varying in length from 57 to 93 ft. In addition, the west end of the structure is widened at two locations to accommodate ramp structures of simple-beam construction. At the east abutment, the roadway is widened to 120 ft to provide access and exit ramps to city streets.

Section 17 of the Connecticut Turnpike, which is located within downtown New Haven, includes in its 1.48-mile length a triple interchange for three major highways as well as the major bridge over the Quinnipiac River. There are also seven individual grade-separation structures of three or four spans each (simple-beam type) varying in length between 40 and 109 ft.

Steel over river was erected by travelers moving on first and third of the four girders. Two falsework bents were used under each 258-ft side span. For center span, steel was cantilevered out to point where the two travelers could set 90-ton connecting pieces.

Hemisphere carries Turnpike through New Haven

Consulting Engineer, New York, N. Y.

The four major construction contracts, exclusive of fencing, signs, lighting and most utility relocations, total over $16,500,000, more than 11 million dollars per mile.

The triple interchange, locally known as the Harbor Interchange, is centered at Water and Franklin Streets but actually extends a half mile along the line of the Turnpike. It will provide direct connections in both directions between the Turnpike and two other major traffic arteries and between it and several New Haven streets.

One of the major arteries to be served is the relocated Route 34, formerly known as the Oak Street Connector. Now under construction, it extends to the west through the heart of the city. It provides four traffic lanes in each direction near the interchange and is flanked with frontage roads and numerous entrance and exit ramps near the heart of the city, making it New Haven's major link with the Turnpike. The second major artery to be served by the Harbor Interchange is the proposed relocation of Route U. S. 5, extending to the north and to Hartford.

Within the 1.48-mile length of Section 17, the eastbound and westbound roadways are at different elevations and as much as 350 ft apart at the triple interchange to provide necessary underclearance and sufficient space for multitudinous interchange roadways. This part of the project, with its interlaced roadways extending in all directions, is called the "can of worms" by the contractors. The total length of paved roadway, varying from one to three lanes in width and exclusive of many embankments to be paved as part of the relocation of Routes 5 and 34, is 5.36 miles, of which 2.19 miles are on structures.

A few years ago, the State of Connecticut filled in a part of the harbor and constructed vertical sand drains in an area that extended into Section 17 for about 1,000 ft from the south. (See "Expressway Crosses New Haven Harbor Front on Hydraulic Fill," by Ernest T. Perkins, CIVIL ENGINEERING, July 1954, p. 37.) This type of construction was extended another 1,000 ft for the Turnpike, frontage roads and various ramps, to near

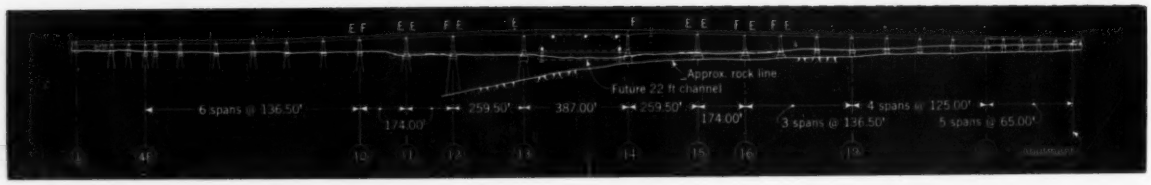


FIG. 1. Most of 0.9-mile-long Quinnipiac River crossing is founded on piles. Four piers support three-span continuous plate-girder unit in center. Two of these piers rest on rock, two on piling driven to rock.

Water Street, the original edge of the harbor.

Foundations for the main Quinnipiac River Bridge and its approaches were constructed by the William M. Moore Building Corp. and Lopier Construction Corp. From the westerly abutment to the river's edge, near Pier 11, low land and mud flats presented difficult design and construction problems. Deep silt intermingled with old and relatively new miscellaneous fill, overlying the typical fine wet sand found in the area, required the use of piles. The bottom of the footings was kept below low-tide level, and untreated timber friction piles were used. Since soil conditions varied radically from pier to pier and even under individual footings, pile lengths varied between 50 and 100 ft.

In the remaining section, extending from Pier 12 to Stiles Street, borings indicated the presence of good sandstone. The rock was very deep at Pier 12, at Els. — 151 and — 171 at the south and north ends of the pier site respectively. From this pier, the rock rises quite rapidly to El. —42 at Pier 14, the east channel pier, and then levels out at El. — 25 to — 38 to the end of Section 17 at Stiles Street.

For the three-span continuous girder unit, the two westerly piers, Nos. 12 and 13, are supported on 14-in. 73-lb steel bearing piles seated in rock, while the two easterly piers, Nos. 14 and 15, are founded directly on rock. Piers 16 and 17 are also founded on rock but Pier 21 has a spread footing on hardpan. Other piers at the easterly end of the structure, including the abutment, are supported on short 10-in. 42-lb steel bearing piles driven to rock.

The two main channel piers are protected with timber fenders. To guard against a destructive fire, Greenheart was specified for both piles and timber for the fenders because of its noninflammable character.

Work from sunken barges

In the mud-flat area west of the river and in the shallow water on both sides of the river, the contractor grounded a series of barges, end to end, to form a working platform along the ends of the pier sites. This method of providing access to the work, in lieu of expensive floating equipment and costly dredging to permit its use, proved both economical and efficient.

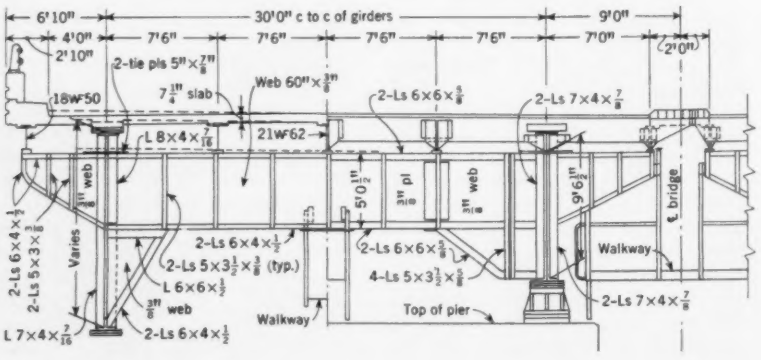
Foundations for the river piers were constructed inside steel sheetpile cofferdams. The excavation required to reach the bottoms of the concrete pier bases was done by open dredging without unwatering the cofferdam. This depth varied from 25 to 43 ft. Where foundation piling was used, the piles were driven under water with a follower. All piers in and near the water, whether on piles or rock; have a tremie seal with its top varying between El. — 21 and — 10. The tremie seal was capped with a reinforced distribution block 5 ft in depth, poured in the dry and against the sheeting. For the deeper piers, forms inside the sheeting were used for bringing the shaft up to El. — 5, the bottom of the stone facing. The largest tremie pour was 1,900 cu yd.

River piers are faced with granite from El. — 5 up to + 8. Above this elevation, two pair of shafts extend upward to support the two pair of girders, each pair connected by a portal strut.

The main river crossing has two roadways each 41 ft wide, separated by a 4-ft median and flanked with emergency walkways 1 ft 6 in. wide, a total overall width of 89 ft inside railings. A longitudinal vertical joint in the center of the median divides the bridge into two parallel structures, each half supported on twin girders.

Use of four girders instead of two for the main span was dictated primarily by the limited depth available after providing the required navigational under-clearance of 60 ft above high tide, ruling grades of 3 percent, and the required access and exit ramps at nearby Stiles Street. The use of four girders, even with the limited web depth, permitted the use of flange sections of relatively normal size with resulting economy in fabrication, handling and erection. To employ two girders and double the flange sections would have necessitated the use of very wide cover plates, quite commonly used in Europe but not fully accepted as good practice in this country.

FIG. 2. Main river spans, seen in typical half section, have 41-ft roadways in each direction. Some floor beams are connected across full 90-ft width of structure to prevent differential deflection between roadways, due to unequal live loads.



The girder depth, back to back of angles, was made 9 ft 6½ in. at the end supports to match the depth of the adjoining simple-span girders; 21 ft 6 in. at the middle supports; and 12 ft 3½ in. for the constant-depth part of the center span. This latter depth was adopted as the maximum that would permit the girders to be shipped by rail. Girder webs vary in thickness from ½ to 1⅛ in. Each flange consists of two 8 x 8 x 1⅛-in. angles with from one to five 26 x 1-in. cover plates.

For main and splice material, silicon steel was originally specified but a later revision called for low-alloy structural steel with slight modifications to permit the use of Bethlehem's Medium Manganese or U.S. Steel Corporation's Manten steel. After Bethlehem Steel received the contract, the cover-plate thickness was reduced to ¾ and 1⅛ in. to facilitate fabrication, and the number of cover plates was increased to a maximum of seven to maintain the net section.

A long concave haunch with a radius of 209 ft was used, primarily for esthetic reasons but also to avoid the radial tension in the web resulting from the more awkward convex haunch at and near the main piers. Relatively thin webs were used, stiffened with both horizontal and vertical stiffeners. Vertical field splices were spaced 75 to 125 ft on centers. The deep haunched section, for a length of 118 ft at each main pier, was provided with a horizontal field splice to keep the depth within limits for handling and shipping.

For each half of the bridge, the 7¼-in. concrete deck is supported on the two girder flanges and on five lines of 21 WF 62-lb stringers, spaced about 7 ft 6 in. on centers. The stringers are continuous and pass over the top of 5-ft floor beams spaced 21 ft 6 in. on centers.

The relative live-load deflections of two adjacent parallel bridges of long span may be quite substantial. With live load on the end spans of the eastbound roadway and on the center span of the westbound roadway of the three-span continuous unit, this relative deflection at the center of the center span would have exceeded 4 in. if no precautions had been taken. A relative motion of this magnitude, which could be easily seen as the two halves of the median moved up or down with respect to each other, might have been disturbing to the traveling public and even considered unsafe. Therefore, a feature was introduced at every fourth floor beam to eliminate this movement. This consisted of splicing the two exterior floorbeams to an additional beam between the two interior girders, thus tying all four girders together and creating a grid system. By this means the tendency toward unequal deflections is translated into small undiscernible angular rotations.

The design of these continuous floor beams, as live-load distributing members of a grid system, was based on the simplifying assumption that they had infinite moment of inertia. This assumption of infinite rigidity yields the maximum possible distribution moments in these members for various conditions of unsymmetrical live loads. Since these floor beams possess some flexibility, the actual distribution moments are necessarily somewhat less than those computed by the above method.

Erecting approach viaducts

Crawler cranes erected most of the approach viaducts from the ground. They then erected two 115-ton traveler derricks on top of the steel previously placed, one near Pier 10 on the west side of the river and the other near Pier 17 on the east side. These travelers ran on the first and third of the four girders, leaving space for a material track near the fourth girder.

Each traveler worked toward the center of the main river span, erecting the 135-ft-long 55-ton simple-span girders in one piece and the 175-ft, 90-ton, simple-span girders in two pieces, using one falsework bent. Two falsework bents were required under the end spans of the three-span continuous unit. The main span was then cantilevered out 125 ft from each of the two channel piers. Each of the two travelers then picked one end of the 108-ft, 90-ton closing piece off a barge and hoisted it into position.

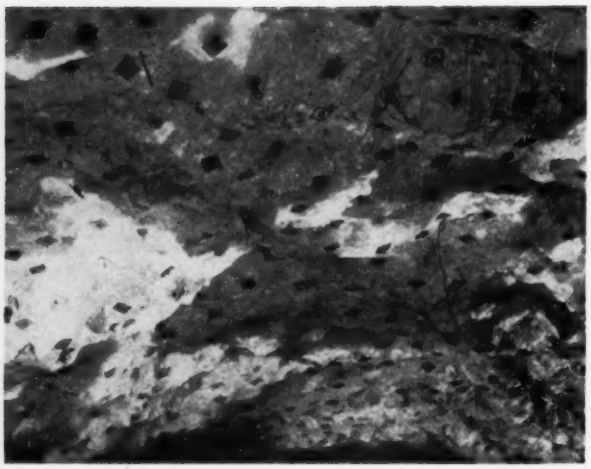
After the closing pieces for the two westerly girders had been raised to final position, the west-end half, on rockers, was jacked eastward until the holes matched and the rivets could be driven. The procedure for closing the two easterly girders was the same. Finally, the floorbeams between the two interior girders were erected, thus tying all four girders together to form a grid system.

Steel erection was started on March 15, 1957, and the first closing section on the river span was placed October 9. Placing of the concrete deck, exclusive of some balustrades, median, etc., was completed on November 17 by C. W. Blakeslee & Sons, Inc., using methods similar to those described for the approach by H. L. Blakeslee in CIVIL ENGINEERING for September 1957, p. 60. All work, exclusive of some painting of structural steel, was completed and ready for the opening of the Turnpike on December 31, 1957.

The Connecticut Turnpike is being built by the State Highway Department under the direction of Newman E. Argraves, M. ASCE, Commissioner, with Warren M. Creamer, Chief Engineer; Ernest T. Perkins, Assistant Chief Engineer, Design; and W. T. Schuler, Assistant Chief Engineer, Construction.

D. B. Steinman, M. ASCE, consulting engineer of New York, was retained as contracting engineer for design and supervision of construction for all work in Section 17. The author was in charge of this project for Dr. Steinman.

Connections to Connecticut Turnpike and its Quinnipiac River crossing are a major part of the work in New Haven. Relocated Route 34 in left foreground and Route 5 at middle left are principal arteries.



Rock bolts are used to support transformer-hall roof in power plant of Snowy Mountains Hydroelectric Power Authority, Australia. Bolts hold broken rock so as to form diaphragm with a thickness somewhat less than the bolt length but having definite structural properties, which can be computed. Roof support was found unnecessary after experiments and tests.

ROCK BOLTING speeds

THOMAS A. LANG, A.M. ASCE, Associate Commissioner, Snowy

A diaphragm having definite structural properties can be formed by the use of rock bolts even in badly fractured rock. Such bolts were used to create a structural entity in excavations for the T1 Power Station of the Snowy Mountains project in Australia, after investigations with photoelastic models as well as by small- and large-scale tests using uncoherent crushed rock material.

The T1 Power Station, on the Tumut River in southeastern Australia, is the first underground plant to be constructed by the Snowy Mountains Hydroelectric Authority. It takes water from Adaminaby Dam, a rockfill structure 380 ft high storing 3 million acre-ft, and from other sources including Tumut Pond Dam, a concrete arch 283 ft high.

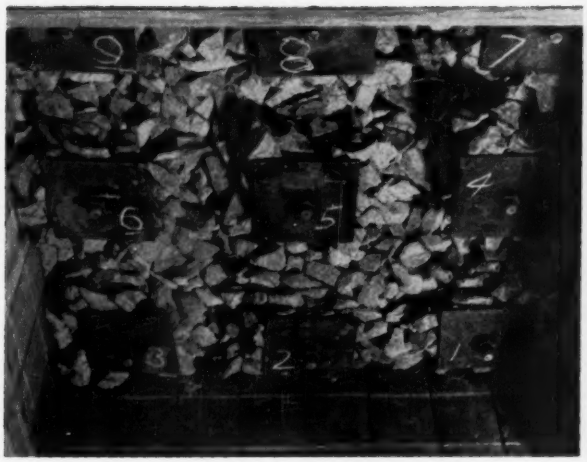
The power plant has a capacity of 320,000 kw in four generators directly connected to vertical Francis-type turbines operating at a 1,100-ft head. The generator hall has a maximum height of 105 ft and a width of 59 ft. The adjacent transformer hall is 43 ft high and 56 ft wide. Vehicular access is through a tunnel about 1,300 ft long on a 12.5-percent grade leading down into the plant. Personnel access is by means of a concrete-lined vertical elevator shaft 10 ft in diameter and 1,200 ft deep.

Two types of rock predominate—granite and granitic gneiss. Both are extensively jointed. Although the jointing is not developed in a regular pattern, it was possible to distinguish joints running in three principal directions. Joints in the granitic gneiss were usually spaced from 6 in. to 2 ft apart. Joint surfaces were usually smooth and slicken-sided, and dark green from thin coatings of chlorite. Clay coatings were not common and most joints were tightly closed.

In the granite the joint spacing was variable but generally from 1 to 5 ft apart. Slicken-sided joints were not as common as in the gneiss. Most of the joints were tightly closed but some were open, limonite stained and water bearing.

Another geological structure of importance was a persistent, nearly horizontal zone of close fracturing a few inches wide, with heavy limonite staining, which occurred throughout the generator hall and transformer hall.

In the past decade, rock bolts have come more and more into prominence as a means of supporting rock excavations. The view that rock bolts only "pin" or "nail" loose blocks or slabs of rock to the sounder rock behind them is erroneous. Rock bolts are useful for this purpose but their use without full understanding of their action is uneconomical and dangerous. Rock bolts can be used to form a diaphragm of ma-



Load of 13,000 lb was supported in 4 x 4-ft box filled with 1½ to 2¼-in. broken stone bolted only to itself. Chicken-wire netting, 2-in. by 24-gage, was placed under bolt heads and loading—9 cycles at 5,000 to 13,000 lb—was applied in apparatus at right. Wire was cut as shown in close-up above, and load reapplied. After a period under load some fragments fell.

Snowy Mountains Project

Mountains Hydroelectric Authority, New South Wales, Australia

terial having a thickness somewhat less than the length of the bolt. This diaphragm can be used as a structural member; its properties can be ascertained and its behavior can be assessed and designed for.

If rock bolts are to be designed to make a structural member, their behavior in relation to both intact and jointed rock must be known. This requires knowledge of the behavior of the bolts and, more important, behavior of the jointed rock, both with and without the bolts. In an excavation with a roof span of some 77 ft like this powerhouse, the behavior of the jointed rock in the roof is of the greatest importance, particularly if there is any possibility that a tension zone will occur. Photoelastic studies using gelatin models were made of this condition. A model constructed of plastic blocks gave some unusual results under test.

Rock found in excavations varies from a solid mass to material that is highly crushed and fractured. A most unusual series of tests was made to simulate actual conditions. One test consisted simply of a rectangular box with a transparent plastic front, filled with crushed rock of small (3/16-in.) size into which model rock bolts were inserted. The mass was first compacted by vibration to eliminate some of the looseness inherent in the material. Then the bolts were simply inserted into the mass and tightened. When the box was inverted, the material stayed inside it.

A second test was made with an ordinary household bucket. The lateral pressure developed by the bolts was sufficient, when the bucket was inverted, to support not only the weight of the material in the bucket but an external load as well.

Experiments, including some with marbles and with plastic cylindrical rods 3 x ¼ in., have indicated a relationship between the clear space between bolt washers, the mean particle size, the bolt length, and the bolt tension. Experiments on a larger scale were made with a box 4 x 4 x 4 ft with vibrating-wire pressure cells mounted on the sides and a hydraulic jack assembly used to apply and measure central loads. From the small-scale tests it was concluded that bolting of the crushed rock caused the uncoherent mass of rock fragments to act as a quasi-elastic diaphragm between the ends of the bolts.

Investigations demonstrate that: (1) crushed rock can be stabilized by rock bolts so that the diaphragms formed between the ends of the bolts will behave as an integral quasi-plastic structural member; (2) loading and unloading causes readjustment of the fragments, with a reduction in the

In simple experiment made with an ordinary bucket, bolted rock fragments carried load of 40 lb.

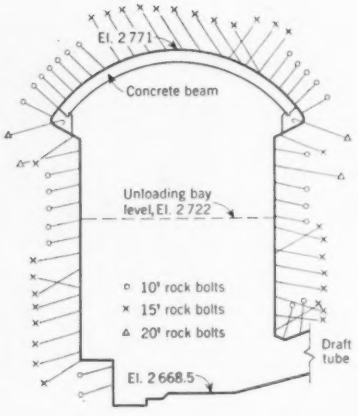


FIG. 1. In machine hall, bolts were spaced about 5 ft x 5 ft. Those in wall were grouted.

tension of the bolts, thus demonstrating the need for retightening the bolts after vibration or other working; (3) it is important to support such loose material so as to prevent unraveling of the whole fractured mass behind the bolts when under load; and (4) only a very flimsy support is needed to hold the loose material in the tension-zone vault between the bolt washers.

Tests have shown that when the bolted material is just stable there is a relation between the clear space, s, between the bolt washers, and the mean particle size, m. This has not been fully resolved but the ratio

$$F = s/m$$

has proved to be a useful parameter. At an F value of 3, even marbles were always stable. If the F number was 4, the marbles invariably failed but crushed rock could be held in some cases.

Chicken wire holds rock

The very flimsy support needed to prevent the start of raveling was demonstrated by the use of 2-in., 24-gage chicken wire under the bolt washers. There was little bulging of the wire netting even after repeated loading to above 10,000 lb on the contents of a box 4 ft square.

In excavating the T1 Power Station, rock bolts were used to create a self-supporting structure out of the jointed rock in the roof, pending installation of the permanent concrete ribs. At the start of the work it was feared that the rock bolts would not be adequate protection in an excavation of this size, and the contractor used light supplementary steel supports in the generator-hall excavation. This steel support consisted of 8 x 6-in. I-beam sections and 12 x 8-in. I-beams spanning the pilot heading. Since these would take only light loads, gaging points were established to determine the actual load.

In an area where geologists had indicated that the intersection of rock joints could give trouble, gages showed a load of about 100 tons. More rock bolts were installed and particular attention was given to any unusual indications of rock noise. Later, when this particular steel support was removed to permit placing of the permanent concrete ribs, no rock fell and no movement could be detected. Similarly, all the other steel supports were removed with no trouble, apart from minor scaling. Following this experience in the generator hall, the transformer hall was excavated using rock bolts alone.

Where large areas such as the machine and transformer halls here described are to be supported by rock bolts, it is desirable to design a general pattern of bolting rather than to bolt only where inspection indicates need. The pattern is based on the best available geological information concerning joint location and major geological structure as well as careful appraisal of information from rock-noise stations and rock behavior instruments. The approximate number of bolts in each row and the distance between rows are made such that one or more rows can be installed after each round of blasting is fired, with the result that the roof is always bolted to within a few feet of the face. Use of a grid pattern enables crews to work systematically and quickly and permits easy checking of the bolts after installation and again after blasting. These advantages far outweigh the cost of the few extra bolts that may be required for the grid arrangement.

Bolts should be installed as soon as possible after the surface to be supported is exposed. This applies to both roof and wall. The bolts are installed and tightened to an established minimum tension so that rock joints are prevented from moving and are protected against vibration from blasting.

On this work it was found that 5 percent of the bolts became loose, that is, lost some of their tension up to 10 or 15 ft behind the working face. Loosening of bolts was attributed in most cases to small pieces of rock becoming loose immediately under the bearing washers. Most bolts could be retightened satisfactorily by use of the impact wrench or by inserting extra packing between the rock and the nut.

Bolts permit large savings

Use of rock bolts as the major support in excavation of the generator and transformer halls for the T1 Power Station of the Snowy Mountains project has been successful and has been the means of preventing any major rock falls either during excavation and construction of the roof or during excavation of the generator hall. Strain meter readings indicating high loads, which were confirmed by cracking and spalling of the concrete in some of the concrete ribs, would indicate that fracture and cracking of the rock were to be expected. That this did not occur is due to the rock bolting. The bolts, 10 to 15 ft long, created a diaphragm some 7 to 10 ft thick across the whole excavation, which in effect is behaving as an integral elastic shell.

Investigations into the bolting of crushed rock material have demonstrated that it is feasible and practicable to reconstitute highly fractured and closely jointed rock with rock bolts and relatively light steel mesh. Estimates of the quantity of conventional steel-rib support that would have been required for the machine hall roof as against the rock bolt support show that the weight of steel required for ribs would have been eight times greater than that for bolts, and the cost five times greater.

(This article is based on the paper presented by Mr. Lang at the ASCE Annual Convention in October, before the Power Division session presided over by Adolph J. Ackerman, chairman of the Division's Education Task Committee. This paper was a part of the four-session Symposium on Underground Power Plants arranged by R. A. Sutherland, MASCE, of Ebasco Services, Inc.)

Estimating and bidding on heavy construction

EUGENE RAU, M. ASCE, Vice President and Chief Engineer, J. Rich Steers, Inc., New York, N. Y.

Successful estimating of costs on heavy construction projects depends on eliminating or properly evaluating the unknowns. Unknowns range from subsurface soils to labor and business conditions during the life of the job. This applies equally to engineers who represent the owner or public body, and to contractors.

The engineer's estimate must be factual to give the owner a correct figure for the budget. If it is too high the project may never start; if it is too low there may not be enough money available to complete the work. The contractor must estimate a job sufficiently high to return a fair and reasonable profit. Yet he must plan a way to do the job more economically than others so he can get the work.

Estimates made by taking unit prices from a previous, somewhat similar job are frequently used by engineers and by some contractors. Particularly in a time of fluctuating prices, such an estimate may be far out of line. It can result in serious embarrassment to the engineer estimator and may leave a contractor out in the cold or, and this can be much worse, with a greatly underpriced contract.

On heavy construction every job is different. Estimating in this field is difficult because of the many unknowns. These are a challenge to ingenuity in planning the work but they require a great deal of study and close attention to detail in preparing a proper estimate.

The first thing our firm does after receiving plans and specifications for a job is to become familiar with the kind of work required and the conditions under which it is to be handled. From these quick observations we consider several methods by which the job might be done.

The next step is to visit the job site and select the method that is the most feasible and the cheapest. During this visit it is necessary to determine how access can be obtained—whether by land or by water. If the job is on land it may be necessary to construct an access road or even build a railroad for delivery of materials and supplies. Large areas may have to be cleared to provide working and storage space for materials and parking for equipment and cars. Such work is costly and of course must be included in the bid.

If the job is accessible only by water, we determine the water depth available and check it with the draft of the equipment to be used. If there is not sufficient depth, the cost for necessary flotation dredging is included in the bid. If the job is entirely on water, such as a bridge across a large river, tides and prevailing winds must be studied as well as flood flows and summer low water. Most of this information can be obtained from local authorities but frequently we take observations to check information or obtain new data.

Protection for floating equipment against sudden storms or flash floods can be costly to provide and much more costly to ignore. An area is needed of adequate depth and sufficient size for maneuvering vessels on tow lines, all protected from wind and waves from any probable quarter. On the larger rivers such as the lower Mississippi and the Columbia, floods are predictable, but in mountain areas streams rise very swiftly from sudden storms. It is necessary to have a haven planned for and included in the job costs.

Study of U. S. Coast and Geodetic Survey maps and discussion with people familiar with a particular area will provide knowledge of the speed and direction of tides and flood dangers. All this will be helpful in preparing a proper bid.

Of course, there is a job now and then where there just isn't any shelter and we simply have to hope there will be no bad storm while the equipment is vulnerable. The Texas Tower contract is an example; there we sat in what seemed like the middle of the Atlantic Ocean with nothing for protection but more water. On jobs of this type we obtain all-risk insurance that covers us against unexpected storms—and include it in the estimate. The premium for this insurance is high but we feel the coverage it affords is well worth the cost.

When the major marine equipment necessary on the job, and the distance it must be moved, are determined, we then schedule the number of tug

boats and launches that will be required to move the equipment, materials and personnel. We make sure that we own or have a definite commitment on all major equipment needed quickly on the project. Even scows are scarce so it is necessary to keep their number to a minimum. These are all items of cost and are included in our proposal.

While this preliminary investigation is going on, our estimators make their own check of all items in the permanent structure and all quantities pertaining to the bid units. For example, under the concrete item we take off the number of square feet of forms, classifying them by flat or curved, high or low, bottom or sides, and whether adaptable to reusable panels. We actually make a preliminary design for the forms to obtain a more intelligent estimate of cost.

We also itemize anchor bolts, miscellaneous iron and the like that may be included in the bid unit for concrete. For timber we list every piece required, with its size, length and category. We also itemize all hardware as to size and length. By itemizing such materials in detail we may pick up errors in the computations made by the engineers. Sometimes we find an allowance has been made for contingencies by adding to the bid quantities; this would not have been discovered without a detailed take-off. Having correct quantities and full information permits more accurate planning of the work and reduces errors.

Estimating can be made less hazardous by better subsurface information. It is of the greatest importance to know the strata that must support a structure or be penetrated by bearing piles or sheetpiling. Whether or not material is impervious and stable under a differential head greatly affects plans for unwatering.

Some boring data usually are supplied by the owner. Unfortunately, such information frequently is not adequate and sometimes not dependable. Samples are disturbed and do not reflect actual in-place conditions. Sometimes they convey a wrong picture. Occasionally the borings have been made several hundred feet from the final site chosen for the structure. Some owners do not include boring data with the bid documents. In any case all available data should be obtained and studied.

It is recognized that dewatering the area and working in the dry normally permits the most economical construction. Borings afford the best information for selecting the means for dewatering. Wellpoints are successful in some soils; sumps may be best in a big open cut. Braced sheetpile cofferdams are better for some jobs, and circular sheetpile cells are necessary for others.

Excavation and dewatering are frequently very costly. The method to be employed and its cost should be carefully estimated and included in the bid. A number of companies specialize in dewatering. Their services should be obtained as a check on the contemplated method of construction and possibly they should be brought in as subcontractors for this specialized part of the work.

In estimating heavy construction a lot can be learned from a preliminary schedule. From such a schedule we determine the amount and type of equipment needed and, of course, the amount of time required, which must be adjusted to come within the time allowed in the contract.

The schedule is detailed sufficiently to determine exactly what equipment will be required—the number of derricks, pile drivers and cranes as well as the supporting plant such as launches, scows, trucks and the like. From this list it is possible to determine what equipment the firm has available that will fit the needs of the job and what will have to be purchased or rented. Also from this list we make up our plant rental costs, which include our own equipment.

Good schedule important

From the schedule we determine whether it will be necessary to work more than one shift, or overtime, to complete the contract in the allotted time. If either is necessary, the extra cost of lighting for a night shift or loss of efficiency for night work, as well as any multiple pay that may be required are included in our estimated cost. Sometimes a credit can be taken for the shorter time a piece of expensive equipment is needed on the job as a result of its being worked extra hours.

We use the preliminary schedule to check our final estimate of the total labor. Knowing the amount of equipment needed and the period over which it is to be used, we estimate the personnel necessary to operate it and then compare this total labor cost with our final detailed estimate.

Pricing labor is a most important part of the estimate. We obtain the wage rates that are applicable in the area of the particular job through the international unions or contractor associations. We attempt to find out if men experienced in construction are available and how efficiently they can be expected to work. Although labor rates are fixed in an area, there may not be enough personnel available. Sometimes it becomes necessary to bring labor in from another area at a higher rate. If this happens we may have to pay the additional rate to all the workers and also, in some cases, compensate those from a distance for travel time to and from the job.

On a marine job such as the Texas Towers it is necessary to transport men from some distance to the actual job site. These men are paid while traveling to and from the job, when they are doing no productive work.

We find out whether other contractors working in the area are, or will be, working overtime to hold a labor force. This can cause added expense, which must be included in the estimate. For example, we have had to work men ten hours a day—eight hours at straight time and two hours at double time, a total of 12 pay hours for 10 hours of work. This increases the labor cost 20 percent and usually reduces efficiency. All this must be foreseen and included in the estimate.

When the detailed takeoff of materials, labor and equipment is completed, the items of work are put on estimating sheets. These vary in detail with almost every contractor. The form we use is simple and relatively standard. It consists of seven columns. The first of these is a brief description of the item; the second the quantities for each item; the next two columns, the unit costs for labor and materials; the next two, the money totals for labor and materials; and the last, the total estimated labor and material cost.

Each item of work is considered individually. We try to compare each item with work done in the past and with the number of units we believe can be performed on the prospective job in a certain period of time. Knowing the size of the crew that is necessary to perform the work or operate the equipment, an estimated unit labor cost is set down on the estimating sheets. We obtain prices for materials from at least three sources and use the lowest dependable ones.

When all figures are filled in, the estimate sheets are checked and added up to arrive at the total costs for labor and materials. As a check on the total direct labor cost, it is compared with the schedule mentioned earlier. If the two total labor estimates are not in agreement, both are again studied to determine the actual cost.

Workmen's compensation insurance is a very substantial item in the labor cost of construction. Rates vary with the hazard and the location. Laws and judicial decisions vary among states as well as on marine work, which may come directly under U.S. jurisdiction. For example, rates for many items are

twice as much in New York State as in New Jersey on a number of hazards. Cost of insurance varies up or down with the contractor's accident frequency and severity over the preceding two-year period. The Steers organization is very safety conscious, for humanitarian reasons as well as to reduce costs. We have a good rating and our lower insurance cost alone has enabled us to take a few close jobs. Public liability and property damage insurance also are important; rates are especially high in built-up areas. Rates applicable to specific operations should be obtained from your insurance carrier where any appreciable amount of work is to be undertaken in an unfamiliar area.

Fringe benefits to labor in the form of hospitalization, holidays with pay, and the like must be included in the job costs. Fringe benefits vary considerably, so we determine an average percentage to be added to all labor costs.

Include all costs

Taxes are an important item and vary in different localities. There may be a sales tax on all materials; gasoline or diesel fuel may or may not be taxed for off-the-highway use. One state requires a full vehicle license for off-the-road vehicles moved over state roads. Some states levy special charges on out-of-state firms. These taxes require special study in unfamiliar states and countries.

To the direct costs thus determined we add plant rentals for our own equipment and any plant that must be obtained from an outside source. This list of plants is taken from the schedule mentioned previously.

The next item is overhead, which includes supervision, office operation, timekeeping, purchasing, material handling and engineering. Next our estimated general charges are added. These consist of erection and maintenance cost for the field office, the cost of moving equipment on and off the job, clean-up, adverse weather costs, temporary roads, access and the like. These items add up to a considerable amount, particularly on marine construction, and must be carefully considered. I believe more errors are made in estimating this phase of the bid than in any other, mainly because there is no guide to follow and some items may be forgotten entirely.

Subcontracting is increasingly important in heavy construction. Formerly the foundation for a project was let separately from the superstructure but now authorities and owners realize that it is cheaper to let a general contract for the entire job. On a considerable number of heavy construction jobs the superstructure is now included, which permits a great deal of economical subcontracting of specialty work.

Our choice of subcontractors is based not only on price but also on what we can learn about their reputation, on how they plan a job, how they work, and how quickly they get things done. It is most essential to choose a reliable subcontractor, even though his price may not be the lowest at the outset. We have given work to a subcontractor on what seemed the most advantageous terms only to find that his performance or his interpretation of the contract was far different from what we expected. This was not a happy association for us or for the subcontractor and cost us more than we had hoped to save. Agreements with subcontractors should be very specific as to the duties and rights of each party.

Then comes markup

With this information available, we add our costs for direct labor, fringe benefits, material and various types of insurance, together with those for plant, job overhead, engineering and general charges. To the total cost thus obtained, we must add markup and a bond premium, if required.

Concerning the markup, and you will note I call it markup and not overhead or profit or some other misnomer, I believe more attention should be paid to the percentage used. This percentage must include a proportionate share of executive officers' salaries, estimating department costs (which go on whether or not we are successful on a particular bid), main office overhead, and maintenance and storage-yard costs. The latter is a particularly expensive item in marine construction.

The percentage of markup, which to some may seem large, must include a large amount of general expense and may include little that is actual profit. This is the most misunderstood item and therefore the most underestimated of the entire bid. Many times contractors will estimate the actual cost of a job very accurately and yet add a percentage, which they erroneously call profit, that will not cover their general overhead, much less include the profit to which they are entitled. I again stress the importance of considering the percentage of markup very closely in order to insure that an actual profit is realized.

With a percentage added to the estimated cost of the project, we have finally arrived at the figure we want to bid. At this point we check again to see that the bond premium, if required, is included. This item gets left out more often than any other.

We do not try, and I do not believe any one else should try, to outguess what the other contractors will bid, and get under that. Bid a reasonable price with a reasonable profit and let the low bidder have the job.

If the bid is a lump sum, the final tabulations are easy. For a unit-price job the markup should be distributed among the respective items. All costs should be distributed to each item in accordance with the cost of that particular item rather than by unbalancing the bid. Of course the items of work that come first should carry the costs that come early whether they are applicable to that particular item or not. Expenses for moving onto the job, bonds and the like, should be provided for in the expected periodic pay estimates. Contingencies can come from the percentage retained by the owner.

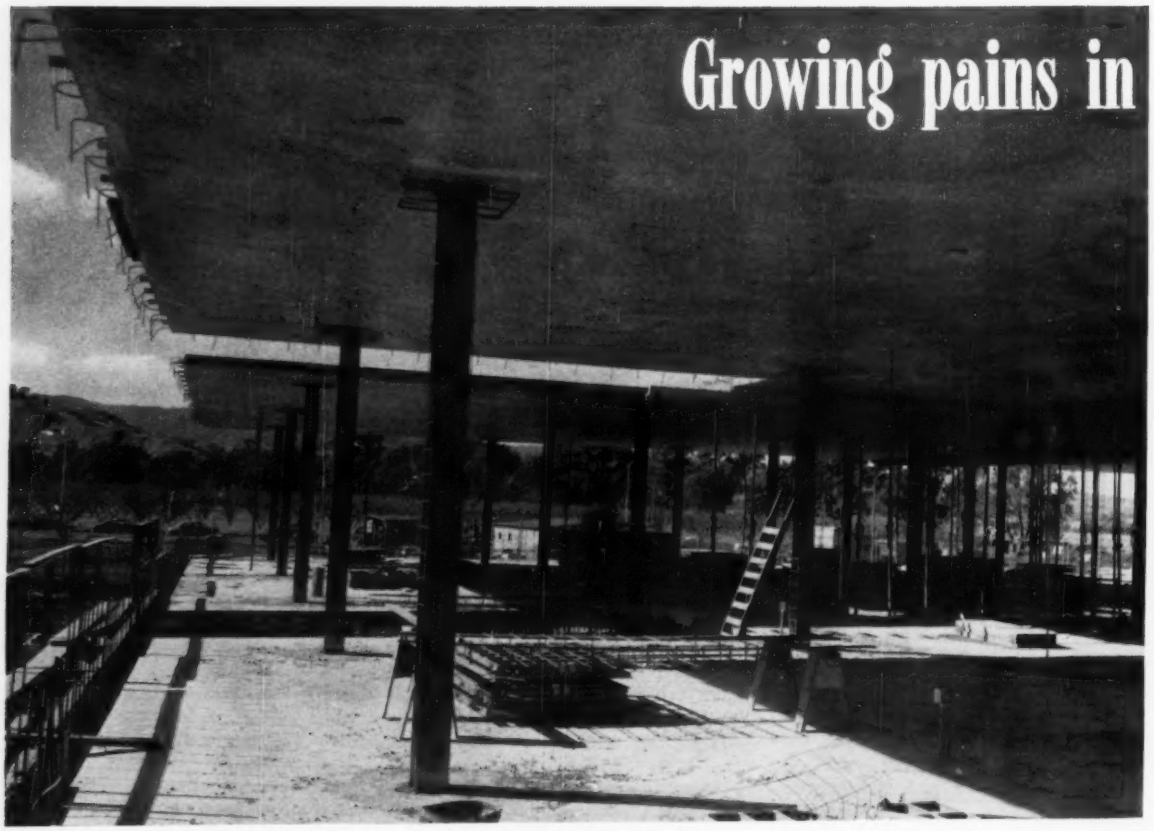
When we are awarded a job, a budget is made up from our estimate showing quantities and labor, including indirect costs. This is given to the project manager for his guidance. From the job we receive a weekly labor report and a complete monthly summary of labor costs. Thus both the job and the office are able to check on how the job is going cost-wise. Overrun items can be checked while remedial action is still possible. On completion of the job, a summary of labor rates and costs is prepared, with notes on special conditions that affected them. This is filed in our main office for use on future estimates.

There is no secret formula for good estimating. It is accomplished by using all the available experience and knowledge in your organization—with a lot of common sense. Briefly, the important steps in preparing a good estimate are: (1) Study the plans and specifications, taking care to analyze every item of work. Search out information; much grief comes from lack of essential data. (2) Visit the site. (3) Study the existing conditions, particularly subsurface conditions. (4) Prepare a schedule of equipment and operations for the entire life of the job. (5) Make a complete take-off of all quantities. (6) Determine labor requirements, anticipating possible changes. (7) Add a sufficient markup to assure a fair return for your work and risk.

If you follow this outline your chances of arriving at a proper bid are very good. And if you get the job it probably will be profitable.

(This article is based on the paper presented by Mr. Rau at the New York Annual Convention, before the Construction Division session presided over by Warren N. Riker, chairman of the Division's Executive Committee.)

Growing pains in



General absence of shoring is evident in this view of a lift-slab job. Concrete wall construction will cover prestressing hardware seen projecting from overhanging slab.

ALLEN H. BROWNFIELD, M. ASCE

Engineers and architects who must design and prepare the plans for prestressed concrete structures need information on difficulties that may be encountered in this new field. The California State Division of Architecture is willing to share its experience—its growing pains in this field—in the hope that it may be of some value to other engineers in reaching better solutions to their problems.

In the past five years this Division has handled 21 contracts for the use of prestressed concrete. Most of them have been for post-tensioned flat-plate lift slabs for one-, two- and three-story buildings. When the present contracts are completed, we will have 15 separate buildings providing 800,000 sq ft of prestressed floors and roofs. Three of these flat-plate structures are of the waffle type, in which small cardboard boxes are used for forms, giving a waffle-like appearance to the ceilings. In addition, one-story prestressed warehouse-type structures covering about 150,000 sq ft of floor area have been built. The Los Angeles office of the Division of Architecture has completed the design of a five-story prestressed lift-slab building and it is now under construction.

The more obvious growing pains encountered in this considerable volume of work can be classified in five categories, as follows:

1. Lack of manufactured inserts and adhesives for installing mechanical, electrical, and plumbing fixtures, and an excess of over-eager salesmen for cement additives, bond breakers, and curing compounds.

2. Lack of effective initial communication and cooperation between architects and engineers covering methods and design features that may make or break a particular project.

3. Lack of the laboratory research needed to simplify details and yet yield safe and economical structures.

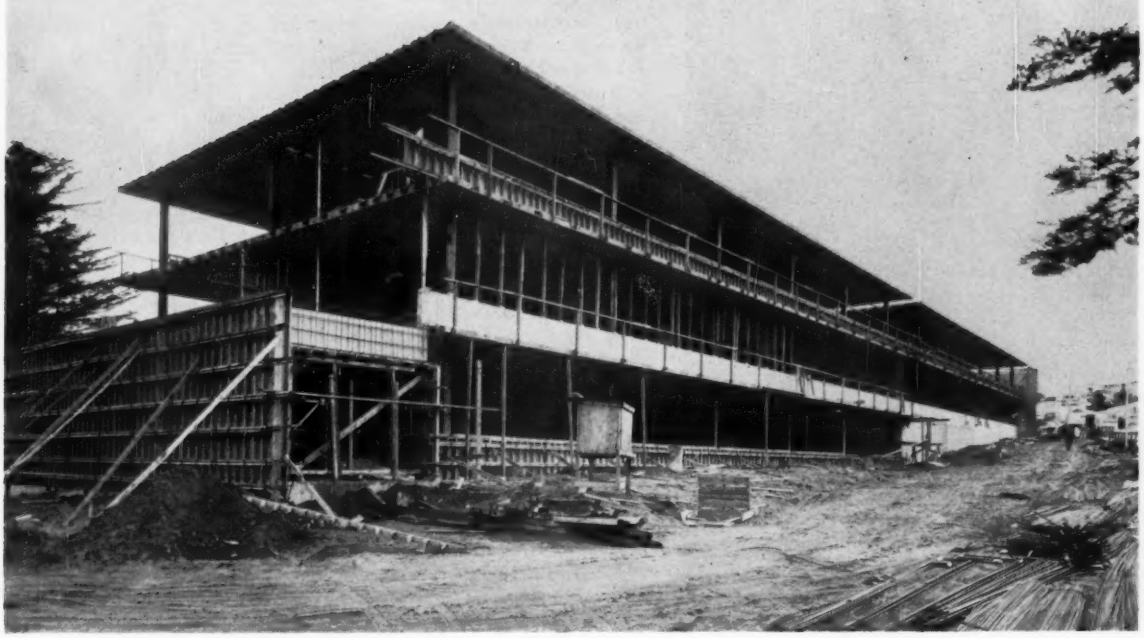
4. Lack of appreciation by general contractors of some of the refinements required to properly fabricate prestressed concrete.

5. Lack of design knowledge of prestressed concrete on the part of engineers and architects and the hesitancy of some to use it where economically justified.

The whole concept of prestressed concrete is based on the use of high-strength concrete and high-strength steel. The slabs are thin, hard, and elastic. Lateral displacement of cables for inserts, conduits or sleeves is generally not permitted. All anchors, sleeves, and small conduits to be preset in the slabs must be in their correct positions before the concrete is placed—holding them there is a major headache. The use of good adhesives and care in placing concrete around inserts by the general contractor is a must on such work.

Use of colored concrete in slabs has

PRESTRESSED CONCRETE BUILDINGS



Slab lifting has been completed on a classroom building for San Francisco State College. Spandrels are being poured. Gaps in roof, defining lift limits, will be closed by poured-in-place concrete.

Supervising Structural Engineer, Division of Architecture, State Department of Public Works, Sacramento, Calif.

proved difficult because the color suppliers are not willing to guarantee their products against staining or bleaching when bond breakers and adhesives are applied. Several contractors have used a well-known admixture which tends to reduce the cement gel and water requirements. This admixture appears to reduce cracking before post-tensioning.

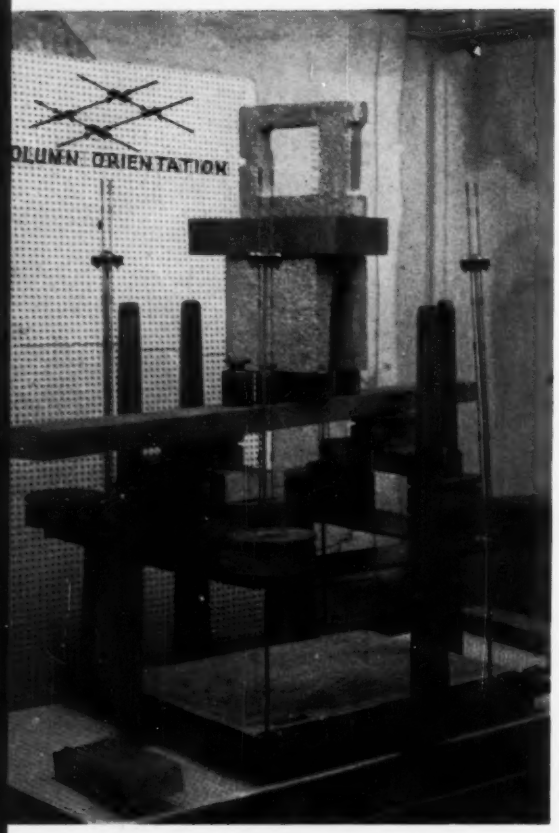
As the use of thin slabs and shells becomes more popular, there will be an increasingly large demand for neat, compact, exposed fixtures combining heat, light, ventilation, and telephone equipment.

The second problem is lack of communication among the designer groups. This difficulty probably can be reduced by demanding that the semi-technical press desist from publishing so many glamour articles and devote more space to construction features, cost data, and sound design. In many cases the cost of these structures can be justified by the end result, but if this cost is not given it is difficult to evaluate the results in terms of everyday design problems.

Design of our prestressed buildings is based on modular plans. Shear walls are placed, where feasible, on the perimeter or in the closure strips and on the column lines symmetrical about the center of the mass. Large holes and shafts should be placed in the center of panels, and stairwells should be located at the ends of the building, or in wide closure strips between lifted areas.

There is a serious lack of the laboratory research needed to simplify details while providing safe and economical structures. The California Division of Architecture has used research and model studies to answer many questions. The first model, of a single cantilevered column used with lift-slab construction, showed that the column was twice as stiff when lifting started, since the pull is directed toward the base, and free movement of the slab being lifted is prevented by the collars. Euler's formula for the buckling load on a free cantilevered column is correct as the slab approaches the top of the column. The second model, using four columns, showed that rectangular or H-columns would have greater composite stiffness when half of them had their major axis at right angles to that of the other half—with the lifting rods normal to the major axis.

The Materials and Research Laboratory of the California State Division of Highways has been of great assistance to the Division of Architecture. The laboratory is now making a long-time study on shrinkage and creep in one of the slabs. The data, when available, will be valuable to engineers designing slabs stressed in two directions. These data must not be applied indiscriminately, however, to highly stressed continuous beams where the average



Four-column model of lift slab has brass columns ⅛ in. by ¼ in. in cross section to simulate elastic properties of a typical H-section. Floor slab is ¼-in. plywood with center excised to better simulate elastic properties of prototype concrete plate. Photo shows first lift (roof slab) about one-third of way up, with assembly of columns and slab supporting 200-lb load. Single column loaded at top, without lateral support, would carry only 2 lb.

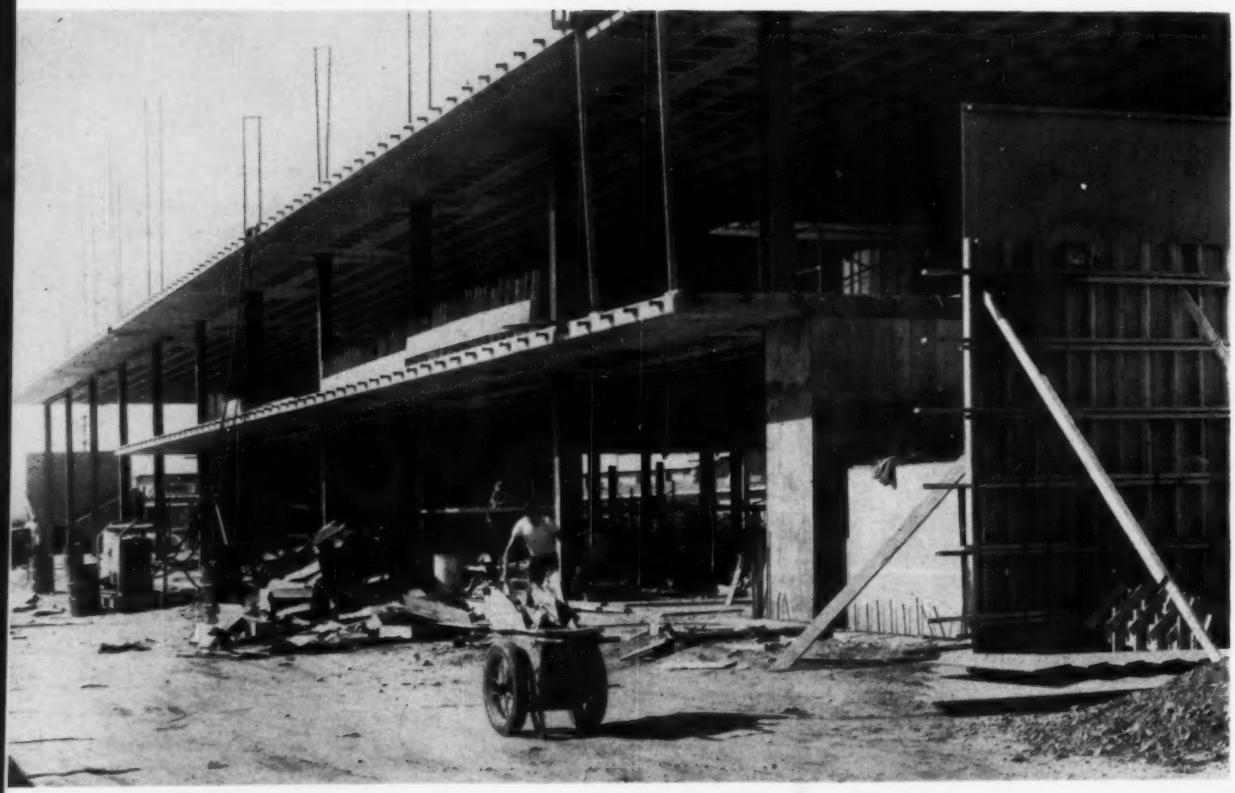
Lifting rods are still in place but lifting has been completed on this classroom building for Sacramento State College. Exposed anchorages of prestressing tendons at slab edge will be enclosed in concrete.

stress level in one direction may be two or three times that used in slabs.

Tests sponsored by the Division of Architecture are also being completed at the University of California under the supervision of Prof. T. Y. Lin, M. ASCE. These tests are part of an overall research program to develop criteria for simpler, safer, and more economical public school buildings. They will furnish factual data on ultimate loads for concrete slabs in the area around lifting collars and safety factors for certain types of prestressed beams and columns. Some of the funds allocated for this purpose will be used for fire tests on pretensioned slabs.

Lack of appreciation of the refinements required to properly fabricate prestressed concrete is a problem with some general contractors. For this reason prestressing in this country has swung definitely toward factory-assembled pretensioned units, because close control is necessary and because the contractors can assemble these units as easily as they do steel or timber. This pretensioning industry will grow in metropolitan areas.

There is also a growing field for job-site fabrication under competent supervision. Contractors are slow to appreciate the need for competent and experienced supervision at the job site and assume that they can get adequate



information and know-how from salesmen. They have not always been able to sift the good advice of a competent engineering vender from that of the over-eager, fast-talking salesman who has no knowledge of the basic problems involved.

With the advent of prestressed columns, our lift-slab structures are becoming 100 percent site fabricated, and they require good coordination and supervision. This job fabrication has thrown a burden on our construction personnel beyond the usual requirements for inspectors. We have now revised our specifications to require the contractor to provide more supervision and to exercise closer coordination on the job, using experienced personnel. Many examples of difficulties caused by a lack of experience can be cited, such as the following:

1. Edge forms may not be sufficiently stiff to prevent rotation and translation by the cable anchors. The parallel wire strands have a natural curvature due to fabricating processes, and require a nominal tension before concrete is placed. (On a recent project the wires provided were nearly straight.)

2. A collar failure can probably be attributed to the failure of the general contractor to provide complete shop plans to the collar fabricator.

3. In one case, short strands were anchored by curving them horizontally in an arc of 4-ft diameter. Two of these curved strands popped out of the concrete while post-tensioning was in progress. They were not buried as deeply as the plans called for. The popping was attributed to the wedging action of the parallel coated wires in the strand. This difficulty can be avoided in the design stage by omitting the mastic and having the wires splayed or by providing the usual dead-end anchors on short strands.

4. A change in the cement brand from that originally tested was responsible for slow curing and for delay in lifting a slab until satisfactory cylinder tests of the cement actually used could be completed.

5. Failure to finish one slab "level" made it necessary to provide temporary fills. The top of this slab constituted the bottom form for the ceiling slab, and the variations in elevation might have been noticeable.

6. Some square steel columns (made up of four plates welded, one to a side) with a twist in them delayed lifting operations for nearly a week while their surfaces were ground down, working from staging.

7. Our specifications require that collars be set so as to offset the slight shortening caused by slab shrinkage and post-tensioning. In one case where this was not done, the pressure was sufficient to spall a corner off a concrete column.

8. Some oversized square steel columns caused considerable delay while collar openings were enlarged. About 160 collars had to be shipped to a mill for this work. In another case, some collar corner welds had to be partially removed.

9. The use of paper boxes for waffle slabs should be avoided during the rainy season. Two of our three jobs of this type faced this problem. Trouble on all but one slab was avoided by drying the boxes. On this slab some chipping was required to remove excess concrete where the boxes had warped.

Lack of design knowledge is always a difficulty when a new design is undertaken, but fortunately it is easily rectified. To overcome it requires time, study, and careful thinking. Also, competent consultants are now available for advice and design. The Division of Architecture has correlated its data with the State Highways Research Laboratory, with private laboratories, the University of California, the State Highways bridge department, fabricators of prestressed steel, and the technical press. The close and intimate cooperation possible within the several sections of the Division of Architecture has made our projects feasible. As a caution to the overoptimistic it should be stated that simple prestressing is relatively easy but the reverse is true of continuous structures until experience has been gained.

There are other problems that may not fall into the above categories. Friction losses in long draped strands of prestressing wire is one. There is need for more research on this problem. We have found it expedient to determine this loss on each project by measuring the pull on each end of the long strands and computing the required over-pull at the ends when two-end jacking is required. Also, at present we favor the use of unbonded strands coated with mastic and wrapped in paper or plastic. We have not successfully isolated wobble and curvature effects using field equipment. Our limited experience with grouted strands in metal sheathing indicates that such sheathing is unsatisfactory on account of friction losses, unless a water-soluble lubricant is placed in the tube. The value of grouting in this case is questionable as is its penetration among the wires.

Another topic is flat, post-tensioned plates. These have been successfully designed for spans varying from 22 to 30 ft in length with slabs varying in thickness from 6 to 9 in. The deeper waffle-type slabs do not have the high factor of safety that flat plates have. Permanent tension in the stems of waffles or joists under service loads must not be permitted unless mild steel has been provided to guard against sudden cracking. Designs should be reviewed for both initial and final steel stress. Our tests at the University of California Laboratory show that the stems crack suddenly through their full depth.

Another problem is lifting collars, which must be uniformly stiff and provide full perimeter bearing. In one case, there are signs of local readjustments where the collars were not equally stiff around their full perimeters. This was caused by cutouts for lifting rods.

Time and material saved—but little money

Our prestressed concrete facilities are serving their intended purposes satisfactorily. Our experience has shown that: (1) post-tensioned flat slabs are level and crack free; (2) fenestration is installed without adjustments for normal deflections that occur in poured concrete buildings where floor fills are omitted; (3) prestressing permits control of dead-load deflection, which cannot be so easily controlled with normal concrete; and (4) shrinkage and creep cause a slight readjustment in stresses, a large part of which is lost before closure and shear walls are placed.

Time and material are saved but there is very little saving in unit costs. Working with a new material, we have not been able to take full advantage of all its useful properties in the first structures. Inspection costs have been higher than for normal concrete but should decrease as the construction industry becomes more familiar with the process. Costs of prestressing and slab lifting have decreased; this is not true of any other construction process in the past three years.

It is believed that this country will soon forge ahead in building economical types of prestressed-concrete structures. About 200 plants are now operating in the United States; in 1953 there were none. Another hundred plants are now in the design or development stage.

State Architect Anson Boyd heads our program in the Division of Architecture. C. M. Herd, Chief Construction Engineer of the Division, is intimately connected with all phases of the work. Charles Peterson, Principal Structural Engineer, is in responsible charge.

(This article is based on a talk given by the author before the Sacramento Section of ASCE.)

Registration in Canada moves ahead

J. MURRAY MUIR, Secretary-Treasurer, Canadian Council of Professional Engineers, Toronto, Canada

In Canada registration is a responsibility of the individual provinces as it is of the states in the United States. Legislation for registration first appeared on the statutes of the Canadian provinces immediately following World War I, and by 1922 seven provincial Acts were in operation. By the mid 1930's there was evidence of a need for more teeth in these Acts, and revision of existing legislation was the order of the day. At that time, too, came the brief reign of the so-called "grandfather clause."

Today all ten provinces as well as the Yukon Territory have Acts governing the practice of professional engineering. The total number of registered professional engineers is approximately 29,000—equal to about 320,000 registrants in the United States, adjusting for the difference in population. Of the 29,000, over 75 percent are in Ontario and Quebec, a natural result of the concentration of population and industry in these two provinces.

The basic concept of registration in Canada is no different from that in the United States. It is designed to provide the necessary protection for the public. In defining what constitutes professional engineering, many variations of the theme have been put on paper. One of the difficulties has been that the definitions have been long, detailed, and with changing times, restricting. Some of the more recent Acts have endeavored to correct this defect by the use of more general, but yet definitive, terms. The recent Act of Prince Edward Island, one of the last provinces to adopt registration, includes the following definition:

"'Engineer' means a person who through specialized education, training and experience, is skilled in the principles and practice of engineering.

"'Engineering' means the science and art of designing; investigating; supervising the construction, maintenance or operation of; making specifications, inventories or appraisals of, and consultations or reports on; machinery, structures, works, plants, mines, mineral deposits, processes, transportation systems, transmission systems and communication systems or any part thereof."

In Canada the provincial legislation is administered by the provincial associations, with a council as the ruling body of each. Each association is also empowered to undertake such activities as may advance the status and well-being of professional engineers and maintain a high standard of ethics among its members. Its council possesses disciplinary powers.

This arrangement, it will be evident, is somewhat different from that in the United States, where the state boards of engineering examiners and the societies of professional engineers are separate bodies.

Being autonomous, each association is entitled to its own views on registration. One of the noticeable areas of difference is that of years of experience before registration. Up until about a year ago, there had been the extremes of four years after graduation in one province, and registration immediately following graduation in another. Today the majority of the provinces require a minimum of two years' experience after graduation.

Uniformity sought

In an effort to promote uniformity of practice by the various provincial associations, the Dominion, or as it is known today, the Canadian Council of Professional Engineers, was formed in about 1937. In reality it serves as a round table where representatives can meet to discuss mutual problems. No action is taken without unanimous consent of the member associations.

There have been a number of valuable results from these conferences—a uniform syllabus of examinations, a uniform recommended schedule of minimum salaries for employed engineers, a recommended schedule of minimum fees for consulting engineers, the facilitating of membership transfers from one province to another, and considerable progress towards achieving uniformity in requirements for registration—to name a few.

An important factor in promoting registration has been the efforts that have been made to bring the profession to the attention of the engineering undergraduate as early as possible in his course. Undergraduates are recorded by a member of the association, who is usually a staff member of the university, thus creating an awareness on the part of the student and a sense of responsibility on the part of the members of the profession. Scholarships and loan funds also aid in the program.

Active adoption of public relations programs has been of great benefit to the profession. Early in this endeavor it was evident that most of the missionary work had to be done among the engineers themselves. To be effective, a public relations program must be a continuing activity, and every engineer in the profession must participate.

Enforcement

The general feeling is that education and reasonable persuasion are preferable to the big club in governing the practice of professional engineering. This does not mean that the teeth in the various Acts are not used when stern measures are indicated. In such cases the person illegally practicing as a professional engineer or holding himself out to be one, may be brought before the local police court and if found guilty, fined a sum ranging from one to two hundred dollars or given a jail sentence if the fine is not paid.

An effective aid to enforcement is the increasing practice of employers of professional engineers to require registration as a condition of employment. This has developed partly from the public relations program and partly from the fact that professional engineers are now to be found in the senior executive positions, and they are conscious of the value of professional recognition.

(This article is taken from the paper presented by Mr. Muir at the ASCE Buffalo Convention, before the Conditions of Practice session arranged by the ASCE Committee on Registration of Engineers, with David G. Baillie, Jr., chairman of the Committee, as moderator.)

Ore dock 1,131 ft long in Venezuela consists of three barge sections towed from U. S. and quickly mounted on caissons.

Harbor facilities without a harbor

JOSEPH D. LEWIN, M. ASCE, Assistant to the President, DeLong Corporation, New York, N. Y.

Since ancient times the economic development of nations has depended on water transport and on efficient means of transferring goods between the land and ships. Where harbor facilities are inadequate or overloaded, the transfer of goods becomes expensive and sometimes prohibitive. A few examples will serve to illustrate this type of problem.

A Near East country established a new and modern cement mill in a location where coal had to be brought in by water and the cement shipped out by water. The plan was to develop docking facilities nearby along the seashore. However, a more complete investigation revealed that the maritime works would be too expensive and would require continuous maintenance, making the cost prohibitive. The cement mill now stands idle and the plan has come to naught.

Another case is that of an old harbor which formerly was sufficient for the existing traffic. However, new developments increased the traffic volume to such an extent that ships were forced to wait for weeks to be docked. The demurrage charges raised the cost of unloading to $10 per ton. This harbor was fine for small ships with shallow draft. Larger ships would require some dredging, but the more modern ships would require deep dredging of a waterway 105 miles long and the continuous upkeep of such a channel, thus changing the entire economic picture for this harbor.

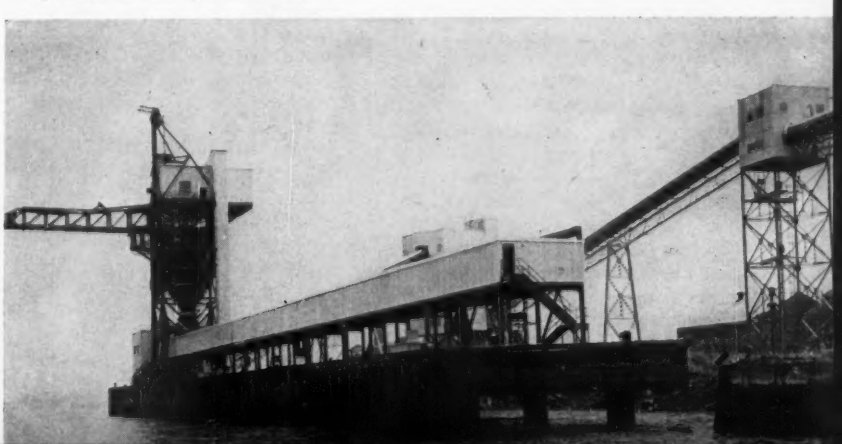
Two main harbor problems

Two main causes account for most of the difficulties encountered in the development of harbors. First, many maritime communities have been developed either along a river or at the mouth of a river—often in the river delta. Many rivers carry a considerable silt load which is deposited at the mouth and is one of the causes of shallow channels. Under such circumstances the maintenance of a navigable channel presents a serious problem. If the harbor is on the river or at its mouth, any deepening of the channel increases the sediment-carrying capacity of the flowing water. The greater and deeper the channel, the greater the sediment load, and the greater the problem of maintenance. If the harbor is located on the seashore, the lateral currents try to level out any depressions and continuously fill in the dredged channel, thus again necessitating continuous maintenance dredging.

The second main difficulty occurs where there are natural deep bays perfectly suited for harbor development but where these are bordered by steep mountains, cliffs or bluffs, which fall rapidly to the sea, leaving narrow beaches or no beaches at all. This type of terrain makes it difficult to get to the harbor from the hinterland. The sheer cliffs make the construction of approach railroads and highways very expensive, if not prohibitive.

The ideal situation for a dock, pier or wharf, where ships can load and unload, is naturally at a navigable depth. The present trend of ship development seems to indicate that such facilities should provide a 35- to 40-ft depth. A structure placed out in the water far enough to obtain these depths for docking should offer the least possible interference to the natural regime of sediment movement, thereby insuring self-maintenance of the navigable depth. This requirement precludes any types of solid construction, such as wharves built with masonry, concrete, or sheetpiling, and

Coal-handling dock in New York's East River, for Consolidated Edison Co., is supported on steel-pipe caissons.



SS "Black Dragon" unloads in Gironde River, France, at DeLong offshore pier. Cargo on pallets is transferred to shore by aerial tramway developed by U. S. Army.

calls for structures supported by the least possible number of piles or caissons.

A study of the relative merits of piles and caissons shows that the bearing capacity of a caisson of 6-ft diameter is equal to that of 15 concrete piles of 16-in. diameter. A comparison of the caisson with the piles as regards resistance to the current and interference with the sediment regime, shows an advantage of 6 to 20 in favor of the former. Further, one caisson is cheaper and more quickly installed than a multitude of piles. These considerations have led to the development of steel and concrete caissons to support dock structures, and their advantages have been proved in many cases. The most remarkable of such offshore structures is the Texas Tower, which stands on three caissons 10 ft in diameter, 163 ft apart, and nearly 190 ft long. (See article by Gordon F. A. Fletcher, M. ASCE, in CIVIL ENGINEERING for January 1956.) During construction, one of these 6,000-ton structures was subjected to hurricane winds and to ocean waves as high as 65 ft, and withstood these forces without any damage.

Self-elevating offshore piers

Caisson-supported piers have another advantage in that the added cost for greater depths is very small, normally less than 10 cents per ft of depth per sq ft of deck area. Therefore such piers can be economically located at greater navigable depths than can conventional solid-type piers, thus permitting docking of larger ships and eliminating transloading to shallow-draft vessels. Since transportation in larger ships is cheaper, and since transloading is eliminated, cargoes can be delivered or shipped at lower rates, thus improving the economics of the harbor.

In constructing a caisson-supported pier, widely spaced caissons are capped by a platform, either of steel, reinforced concrete or prestressed concrete, to form the docking facility. Barge-like steel platforms can be prefabricated at a distance and towed to the site. Here the caissons are dropped through wells in the deck, and the platform is jacked up on the caissons to the desired elevation. Such self-elevating platforms have been developed in the past ten years and have been widely discussed in technical publications, for example in CIVIL ENGINEERING for May and December 1953.

The pier deck is usually designed for a live load of 400 psf and for any desired railroad, crane, and other concentrated loads. The pier may have fixed facilities or mechanical unloading equipment as on the East River dock for the Consolidated Edison Company of New York, shown in one of the accompanying photographs. Depending on the live loads to be carried by the pier, the caissons are spaced to support from 2,000 to 4,000 sq ft of dock platform each.

Wide choice of pier sizes

The piers can be arranged in various patterns and can be in various widths, from 30 to 150 ft. The economical length of each section is 300 to 400 ft; longer piers are made up of several sections. The 1,131-ft Orinoco pier in Venezuela consists of three sections, each 377 ft long. To minimize the side thrust from ships, the pier should be oriented in the direction of the prevailing currents or winds if possible.

If the platform is a steel barge, its hull can be utilized for storage and warehousing purposes. Appropriate hatches, with or without covers, can be arranged for access to the various compartments between the bulkheads. Such compartments may be watertight, and used for storage of fuel oil or other liquids. Compartments may be provided with material handling equipment such as conveyors or pneumatic elevators to handle bulk cargo and package freight. Utilization of the hull for storage permits quicker loading and unloading of ships, equalizes traffic between pier and shore, and acts as a shock absorber against demand peaks.

Offshore platforms can also be utilized to support various types of cargo handling equipment, storage sheds, and silos. Such silos can be filled at normal rates and can discharge into ships at much higher rates. Similarly, the discharge of ship loads can be greatly accelerated. The offshore pier can be connected with the shore either by causeway, trestle, or aerial cableway. The choice will depend on the amount and type of goods to be handled, the topography, and the soil conditions.

A trestle connection installed for one of these harbor facilities consists of steel-girder construction for two-way truck and rail traffic. The roadway has a 24-ft width and imbedded rails. Walkways 3 ft wide overhang on each side, and there are handrails for pedestrian use. The trestle is supported by caissons and steel girders spanning two piles, placed 20 ft apart across the centerline of the trestle. Depending on the length of the approach, foundation conditions and traffic load, trestles can be designed of concrete, steel, or timber with spans and systems most suitable for local conditions.

Sky-cars on aerial cableways

Use of an aerial cableway to connect an offshore pier with the land is a new adaption of an old and proven method of mass transportation. Because catenaries are more adaptable to height differences, cableways are particularly useful where shore installations are on high ground or behind a hill. Furthermore, the low cost of cableways makes them advantageous in places where rapid installation is necessary and where cargoes can be palletized.

Through an arrangement between the Corps of Engineers and the Transportation Corps, U. S. Army, a caisson-supported harbor facility was recently towed to France. The pier units and the aerial tramway were erected on the Gironde River, where the tidal range of 16 to 18 ft causes currents up to 4 knots. This installation was part of the Army's "New Offshore Discharge Exercises" (NODEX) in the course of which various unloading methods were tested. The entire facility, including a 600-ft pier and

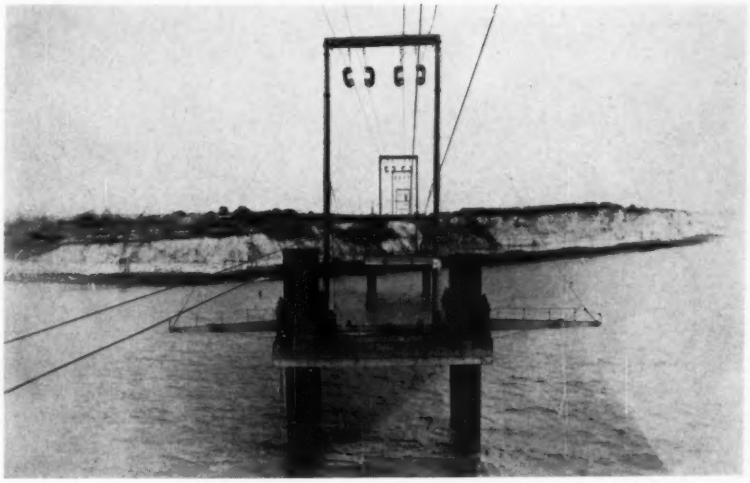
an aerial tramway which extended over a 60-ft cliff to the shore installation, 3,500 ft from the pier, was erected in 17 days by an Army Engineer Company.

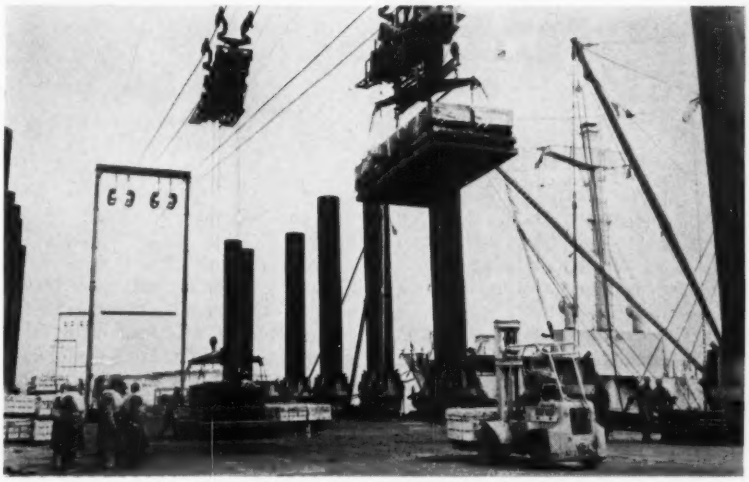
The aerial tramway cables are supported by intermediate platforms, supported by caissons and erected by DeLong air jacks operating on the caissons. The 75-ft towers, spaced 750 to 1,500 ft apart, have outriggers to which the lateral guy wires are attached. The tramway could consist either of two sets of track wires permitting travel by sky-cars in both directions at once, or of turnaround towers at each end permitting an almost unlimited number of cars to move continuously. The sky-cars can be equipped either with pallets or with buckets for bulk-cargo transport. Sky-cars built for the Transportation Corps, U. S. Army, were designed for a 10-ton carrying capacity with a 100-percent overload factor, and travel at an average speed of 18 mph. If the sky-cars are spaced two or three spans apart, the carrying capacity of the tramway will be from 140 to 300 tons per hour, or 3,500 to 7,200 tons per day.

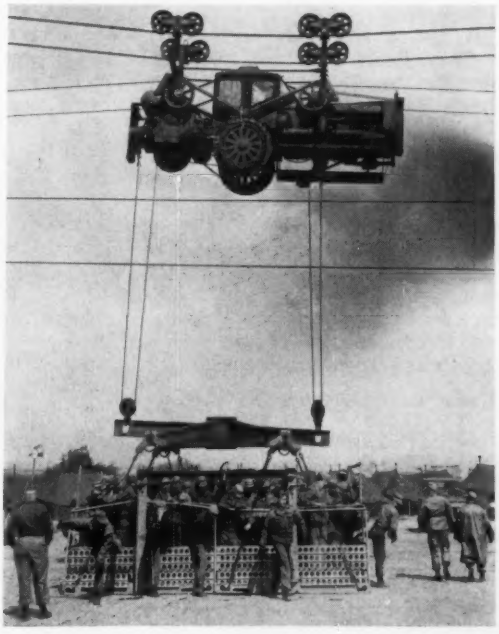
The sky-car provides the mobility of the system. It is a self-propelled, gasoline-engine-driven vehicle. The tractive effort is derived from a bull wheel operated from a heavy-duty transmission. The bull wheel has a 360-deg wrap of the traction rope passed around it, which propels the car as the wheel turns. A power take-off unit drives the 10-ton-capacity winch to which either a 9-ft x 18-ft cargo platform or a bucket is secured. Four pairs of track sheaves suspend the sky-car from the track ropes.

Cargoes from the ships tied up at the pier can be unloaded directly on to the cargo platform and hauled over the tramway system to discharge points on land. Here they are deposited on platforms from which they are immediately loaded, either on trucks or on railroad cars.

Another example of the use of prefabricated self-raising offshore piers was provided by the Transportation Corps, U. S. Army, in its NODEX operation. This consisted in erecting an offshore pier 600 ft long and 90 ft wide and connecting this pier by two Bailey bridges supported by intermediate piers with the remains of a partially destroyed concrete mole. The *SS Mormacpine*, a Victory ship, was berthed beside the pier and 4,168 short tons of cargo were unloaded and brought to the shore in three days. The cargo included all the usual military items, from boxed rations to heavy vehicles.







Aerial tramway provides quick connection from pier to otherwise inaccessible shore. Each platform for 75-ft-high tramway towers is supported by two 6-ft caissons (top view). Aerial spans are 750 to 1,500 ft long. Gasoline-driven self-propelled sky-car shown moving material and men to shore can handle loads up to 18 tons. These photos show U. S. Army exercises in Gironde River, France, an operation of Corps of Engineers and Transportation Corps.

Michigan State Highway Department saves time

getting the most out of

C. A. WEBER, M. ASCE, Deputy Commissioner and Chief Engineer, and **JOHN E. MEYER,**

We engineers are opportunists. We had little or nothing to do with the development of photogrammetry, and many of us turned our backs on this source of engineering data, refusing to ascertain how reliable its results actually were. We can be thankful for the small group of private individuals who had the foresight and courage to invest their money and special talents in commercial organizations set up to take aerial pictures. The engineering profession, and highway engineers in particular, are now reaping the harvest of their efforts.

It was in 1925 that our location engineer, Harry Brightman, prevailed upon the then Highway Commissioner, Frank Rogers, to contract with the Abrams Aerial Survey Corporation for aerial photography on a short hilly section of US-31 along the east coast of Lake Michigan. This has since been referred to as a "kick-in-the-pants" survey because as the story goes, the pilot would kick the cameraman when he thought it was time for an exposure. This of course was before the days of the intervalometer and the automatic camera.

Whole state photographed

Aerial photography is now a "must" in the everyday operation of our department and will become increasingly so as our experience in its use widens. It has materially reduced the time required for a route planning study, while at the same time it has lent more authority to our recommendations. Estimates indicate that where its end products have been used in preliminary surveys, a reduction of more than 70 percent of survey-party time has been realized.

Our files contain complete photographic (stereoscopic) coverage of the entire State of Michigan. This is at scales of 3 and 4 in. to the mile, with several isolated sections at about 2,000 ft to the inch. A considerable amount is available at various other scales. Our customary procedure is to utilize the available small-scale photography for very preliminary work and for general area studies, after which a special aerial survey at a predetermined larger scale is obtained over a specific area. From experience, we have found that the most practical photo scale for the preliminary work is 800 ft to the inch. Through photographic projection, we know that negatives at this particular scale can be enlarged up to 200 ft to the inch.

About 90 percent of all our new aerial photography made on special contract is at 800 ft to the inch. This is satisfactory for all work except in concentrated metropolitan areas. Where a special study is required in such areas, we have had numerous surveys made at 400 ft to the inch. For the study of certain types of grade separations in heavily built-up areas, we have even resorted to surveys at 200 ft to the inch with enlargements up to 40 and 50 ft to the inch.

Since good photo interpretation results in a minimum of field work, every engineer in the Route Location Section is thoroughly trained in stereoscopy. The contact print and folding pocket stereoscope are standard equipment. Each engineer undergoes a concentrated in-service training course in an effort to develop his powers of deduction and association, which are vital to good photo interpretation.

Thus our methods revolve around simple contact prints and the stereoscope. Perhaps these may be considered elementary and unworthy of being described as photogrammetry, but we have found them invaluable for highway route planning.

Use of uncontrolled mosaics

Use of aerial mosaics has eliminated all preliminary mapping from our survey operations. Our print assemblies are made in the form of stapled mosaics, without any control other than what can be inserted through the use of what we call the "straight-line method" for orientation, and the ability, experience and judgment of the photogrammetric technicians.

Each mosaic is given a title, an approximate scale, and an arrow (essentials of a map in any language) and is then sent to the photo lab for copying to the desired scale. It makes no difference how big these mosaics are. The copy camera can make negatives up to 40 in. square, and there are facilities for copying individual mosaic boards up to 4 ft x 8 ft. A mosaic is copied on one negative if small enough, otherwise in sections.

After copying, the negatives are

and money by . . .

photogrammetry

Route Location Engineer, Michigan State Highway Department, Lansing, Mich.

blueprinted and if they are in sections, the individual blueprints are matched together. The resulting blueprint mosaic can be rolled up or folded as desired by the individual engineer who will use it as a work sheet.

We think of a blueprint mosaic as a preliminary map; it can be made in a hurry and in many cases has been made within an hour of the time it was first requested. We know its shortcomings as an accurate instrument, but its usefulness for our purposes is unsurpassed. It is difficult even to estimate how many hours and miles of walking it has saved our location personnel. It gives the indisputable location of all the cultural features, regardless of the size of the area under study.

The basic route location studies involve a detailed stereoanalysis of the area as depicted on the mosaic and the choice of several possible alignments for further evaluation. Each possible alignment is then investigated as to cost, length of construction, types of soil, construction difficulties, number of structures, cost of right-of-way, property damage, type of crossroad treatment required, esthetics of design and service to the area. Involved in this part of the investigations are many hours of study including some field work, subsurface soundings, public relations, a public hearing, and an analysis of assigned and induced traffic volumes and turning movements.

It then becomes possible to make a recommendation for the highway project under study. The next best solution is named as an alternate. For these selections, alignments are inked on the copy negative to show the centerline, right-of-way, land lines, crossroad treatments, schematic treatments at interchanges, typical cross-sections, outlines of terrain features and other pertinent details.

The negatives are again sent for reproduction, and all details previously inked on the negative show up white on the blue background of the blueprint. This is very effective and constitutes the complete preliminary survey map.

This is our standard procedure. Personnel in all our varied operations have been indoctrinated over the years in the practical value of this photogrammetric end product and now think of it as indispensable. We have discussed this type of map with so many other engineering organizations from other parts of the United States that it is becoming a standard product. We would like to feel that our organization has had some small part in its development.

Special flights for final location

Preliminary alignments, previously determined by the route location studies, are shown on the mosaic blueprints as a white line. By a careful analysis of field methods for obtaining horizontal control in this type of work, we have set up the procedures to be followed before the special aerial photographic flight.

On the ground, a survey party will establish the line shown on the mosaic blueprint. They may or may not stake out the centerline, but by measurement they will set P.I. points and establish points along the centerline from 1,200 to 1,500 ft apart, or at other intervals as field conditions warrant. Each one of these points is then carefully flagged with two 8-ft strips of heavy 18-in. building paper crossed and centered at the centerline stake.

When the special aerial photographs are taken, these crosses can be seen clearly on the prints. Knowing the distance and horizontal angle between, as determined and reported by the survey party, a definite orientation and scale ratio of print distance to ground distance are obtained.

After the aerial photographs are obtained, the location of the desired vertical control is shown on a set of the contact prints which are given to a survey party for the subsequent field work. The party is also furnished with a set of enlargements at a scale of 100 ft to the inch.

It is our practice to locate all trees and buildings within a certain distance of the centerline and to describe the trees by trunk size and type and the buildings by type, size and condition. See Fig. 1. Use of these enlargements eliminates the need for measurements to and location of these features.

A set of the same photographic enlargements is given to the soils engineers, who then review the soil types and their extent on the ground,

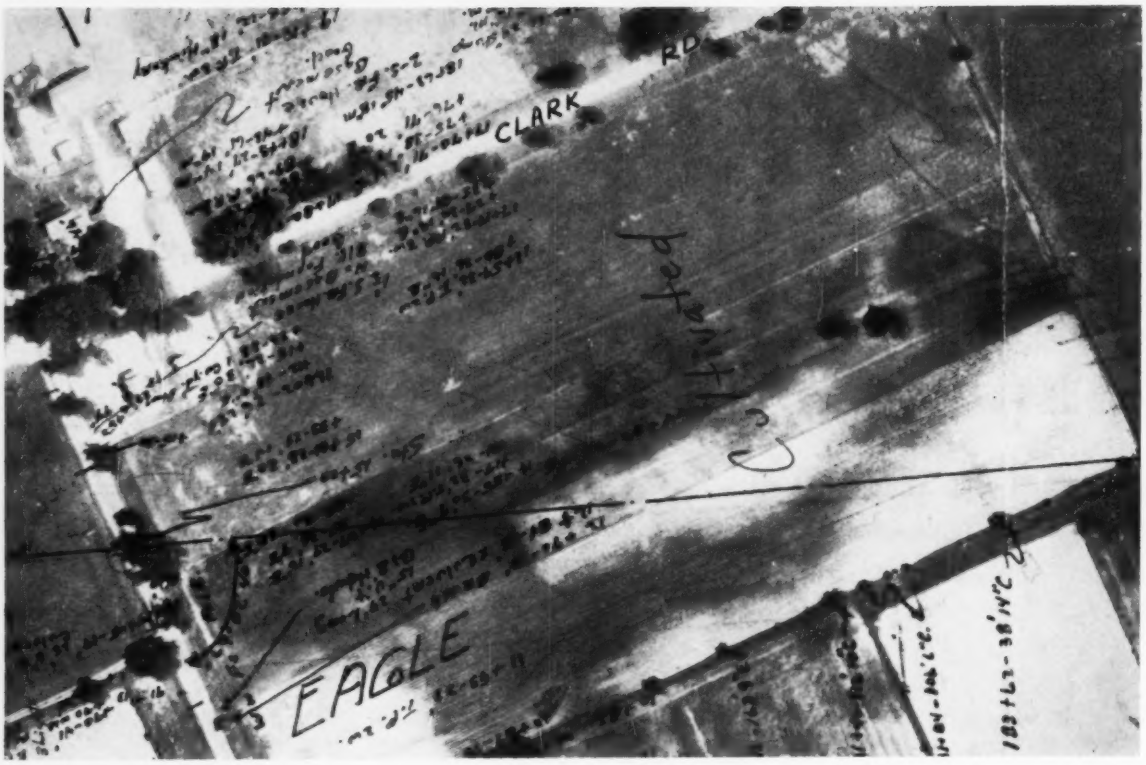


FIG. 1. Section of an actual photographic enlargement carries topographic data that were added by survey personnel in the field. Scale is 1 in. = 200 ft.

with relation to the proposed right-of-way, and delineate them on the prints. See Fig. 2.

These tree and building surveys and soil studies can be in progress while the topographic mapping is in the stereo-plotting stage. The final product is a topographic map at a scale of 1 in. = 100 ft, with a 2-ft contour interval, which is given to the Road Design Section for detailed design of the new route. We estimate that to get the same amount of information to the Design Section through ground surveys would require about 55 percent more time or effort on the part of both the survey and the soils personnel.

At first it may appear that this saving in field time is accomplished at the expense of office time. This may be true in the early stages of training a design squad to take cross-sections from the countour map, where it is necessary to overcome their natural antipathy to a new method. It has been found that a design squad made up of younger personnel can get through the training period much more quickly than an older squad. Our latest case history shows that cross-sections can be taken from the topographic map and plotted in about 65 percent of the time previously required by standard methods.

Our first experience in constructing a section of highway where the engineer's earthwork estimate was obtained from photogrammetric mapping was acquired in 1952. This experience helped us to develop a positive approach to future applications.

Earthwork computed from aerial maps

This first project was an 8-mile section with elevations at the termini of 607 and 615 ft, and elevations between, of about 920 ft. Topographic maps were obtained to a scale of 100 ft to the inch with 2-ft contours covering an area extending about 1,000 ft on each side of a centerline determined by a route location study.

We made mistakes. We found we had obtained more field control than was actually needed. The contour map was not complete because of some sections of dense cedar swamp along the creek beds. Consequently additional field time was required to take cross-sections and topography in these areas. However, despite all difficulties, our final estimates were within the allowable variations from the engineer's estimates.

At present about 35 miles of construction based on plans prepared from photogrammetric mapping is under way. We are only waiting for the completion of this work to prepare a full case history of it for publication. It is anticipated that a similar application of photogrammetric mapping will be made to about 70 more miles of construction in the immediate future.

Use of contour maps for preliminary earthwork computations and profiles is advocated in all standard surveying manuals and academic surveying classes. Why then should so much discussion and research be necessary to permit the use for similar purposes of a topographic map made by stereoplotting from aerial photographs? Is it because the engineering profession still does not accept the topographic map made from aerial photographs as the equal of a similar map made by stadia or plane-table?

How far can we let our prejudices control our thinking? In Michigan we have been making photogrammetric maps for earthwork estimates for a number of years. The engineering pro-

FIG. 2. On another copy of photographic enlargement shown in Fig. 1, soils engineers have recorded soil boundaries and any needed sounding information.

fession makes general use of the quadrangle maps of the U. S. Geological Survey, and if my information is correct, these maps are prepared entirely from aerial photography by stereoplotting. If no USGS map is available for an area in Michigan, we contact private industry and have such a map made for us. The contour interval may be as small as 5 ft.

Of course the success of an aerial mapping operation is dependent on the ability of the stereoplotter operator. However, a careful check of profiles over random lines on a number of our topographic map projects has shown that the topographic map made by aerial photography, through stereoplotting, is as good as or better than the map made by standard field methods as regards accuracy of contours and completeness of cultural detail.

Our confidence in photogrammetry thus rests on a firm base. Should this confidence be any less because of a change in the contour interval? We do not think so. In the past five years, we have made topographic maps at 100 ft to the inch, with 2-ft contours, over about 100 lineal miles of new location. From these maps cross-sections have been taken and earthwork computed.

We have been working to perfect our procedures for many years. Each one has been thoroughly tried out and tested. We have been conservative in adopting new ideas until the previous applications have been thoroughly sold to our own personnel.

We are just now purchasing our own stereoplotting equipment, a second-order instrument which we intend to use initially in making large-scale contour maps of traffic-interchange areas and bridge sites—not for any large extension of control such as a topographic survey of a highway alignment. For the latter, it is believed, a first-order stereoplotting instrument should be used. Soon we expect to acquire a second and a third stereoplotting unit—as soon as we have determined the capacity, eccentricities, and efficiency of our first unit.

In the engineering profession today considerable effort is being expended on work-improvement methods. One widely discussed proposal is to take cross-section readings by stereoplotting equipment from aerial photographs and program them directly into an electronic computing machine. Results from research so far appear to be optimistic but not detailed enough for final conclusions. We are now planning our own research into this method.

Our photogrammetric section now includes registered civil engineers experienced both in highway engineering and in photogrammetry. In addition, we have been able to employ several trained stereoplotting operators. Thus we first acquired the proper personnel, then developed the corresponding techniques as needed. Recently we began to explore the possibility of doing our own aerial photography. Our staff already includes an experienced aerial photographer.

We believe that our organization is trained to take advantage of the possibilities inherent in photogrammetry. We endeavor to look far enough ahead of present needs so that when new needs arise, we will have developed the know-how to satisfy them.

(This article is based on the paper presented by the writers at the ASCE Annual Convention in New York, before a Surveying and Mapping Division session presided over by O. J. Marshall, chairman of the Division's Executive Committee.)

Timber bridge over the Danube, built during Trajan's second Dacian campaign, was one of the wonders of Roman engineering. Bas-relief on Trajan's Column in Rome (after Arosa, Plate 129) pictures structure on which Apollodorus of Damascus reportedly served as engineer.

The Engineer through the Ages

The Architectus of the Roman Empire--Part 4

J. K. FINCH, M. ASCE, Dean Emeritus and Renwick Professor of Civil Engineering, Columbia University, New York, N. Y.

During the forty years from 98 to 138 A.D., when Trajan and his adopted son Hadrian guided affairs of state, the Roman Empire reached its last high-water mark and many notable engineering works were undertaken. The distinction between the native Roman and the Roman of the provinces was passing away. The Italian Peninsula had in fact become one of the provinces of the Empire. Trajan himself was of Spanish birth, and we turn increasingly to areas outside Italy for examples of later Roman works. For Rome, it is true, Trajan sponsored the eleventh aqueduct, the 35-mile-long Trajana of 109 A.D., a special-purpose supply for the Baths of Suriana. But his major works were widely scattered.

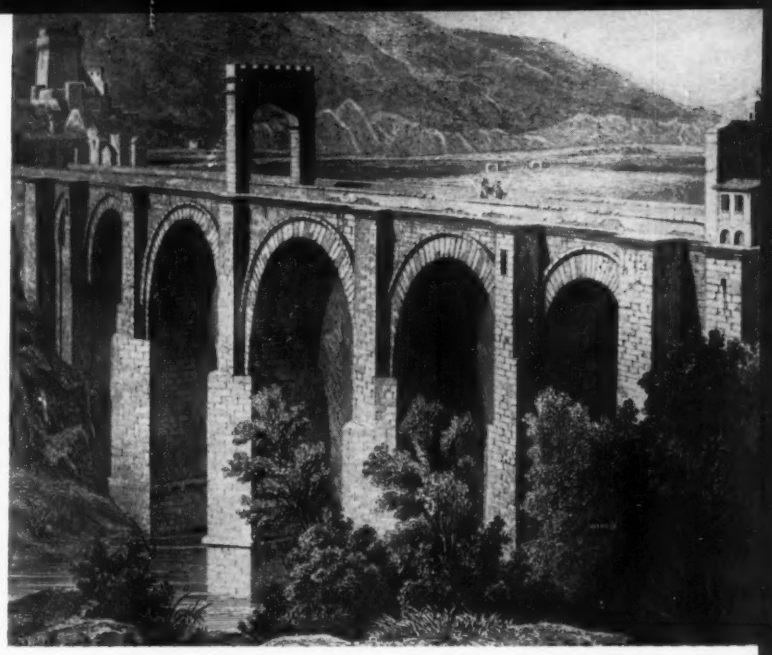
In 112 A.D. he sent his friend, Pliny the Younger, the adopted son and namesake of the author of the famous *Natural History*, to the Province of Bithynia, now the Republic of Turkey. Pliny was "one of the most elegant writers of his day," and fortunately much of his correspondence with Trajan has been preserved. Over a dozen letters in this exchange make it clear that the Roman administrator of the day was sufficiently experienced in construction to conceive large undertakings and carry them through.

There had been a lack of progressive administration in Bithynia which Pliny undertook to remedy. He writes to Trajan on the building of an aqueduct for the city of Nicomedia, a project earlier attempted but twice abandoned; he argues for a similar work for the inhabitants of Sinope, "who are ill supplied with water"; he discusses the pros and cons of a drainage project near "the elegant and beautiful city of Amastris." In another letter he pleads the cause of a volunteer fire company of 150 members "which has not a single instrument suitable for extinguishing fires," and would welcome the gift of a fire-machine—undoubtedly one of the earlier type described by Hero of Alexandria.

Four of the most interesting letters (see Nos. 5, 52, 69 and 70 in *The Letters of Pliny*, translated by Melmath and Besanquet) deal with a project to canalyze a stream leading from a lake near Nicomedia "over which marbles, fruits, woods and all kinds of materials . . . are brought in boats at little trouble or expense, but from thence are conveyed in wagons to the seaside at a much greater charge and with great labor." Pleading for support for "a work which will be of universal benefit," he suggests that Trajan, "if you think proper," send a leveler (*librator*) or *architectus* to make a survey and determine whether the lake lies above the level of the sea." He believes that an old canal attempted by a former king could be used in part, and tells Trajan that he hopes he "may have the glory of executing what kings could only attempt."

Trajan replies with caution, "You must first carefully examine" the lake and its supply of water "lest, by giving it an opening into the sea, it should be totally drained," and he agrees to send "from hence someone skilled in works of this nature." To this Pliny answered:

"To the Emperor Trajan: The apprehensions you express, Sir, . . . are agreeable to that prudence and forethought you so eminently possess; but I think I have found a method to obviate that inconvenience. A channel



Largest of surviving Roman bridges spans the Tagus at Alcantara, Spain. From "Monuments Anciens et Modernes," by Jules Gailhabaud, Paris, 1865, Vol. 1. This monumental work was dedicated to Emperor Trajan, but the engineer, Caius Julius Lacer, managed to perpetuate his name by putting a votive chapel at one end, with the inscription:

"The curious traveler whom strange stories charm
Beholding here on Tagus' rocky bank
This temple to the gods and Caesar built
(It's art tho' great not equal to its stone)
May ask, perchance, whose vow hath made it rise.

"'Tis Lacer, famous for a skill sublime,
Hath built this mighty bridge with massive piers.
'Tis he whose votive gift also arises here
To last through eons of eternal time.

"'Tis Lacer's bridge and Lacer's glorious shrine,
(Such works alone delight the heavenly gods).
Auspicious, sacred gifts are these: this home
He's 'stablished for the gods and lord of Rome."

may be cut from the lake up to the river so as to not quite join them, leaving a narrow strip of land between, preserving the lake. . . . Besides there are several brooks . . . which, if skillfully collected, will supply the lake with water in proportion to what it shall discharge. . . . If the nature of the place should not admit of any of these schemes, the course of the water may be checked by sluices. . . . These, however, and many other particulars will be more skillfully examined into by the surveyor, whom indeed, Sir, you ought to send for it is an enterprise worthy of your attention and magnificence."

Clearly the canal lock was still unknown. Trajan complimented his governor on his "many expedients" to prevent the lake from being drained and agreed to send him a leveler, "as skilled men of that kind are not wanting." Unfortunately, further records are lacking and we do not know whether Pliny successfully completed these projects.

Apollodorus and the Danube Bridge

One of the most famous bridges of Trajan's day was the trussed timber arch on stone piers erected over the Danube in connection with the Dacian campaign in which Frontinus served so brilliantly. This crossing, near Warkel in Hungary, below the rapids of the Iron Gate, was built, it is said, under the direction of a noted Greek engineer-architect, Apollodorus of Damascus. Twenty wood arches, each having the extraordinary span of 170 ft, are said to have carried the roadway 150 ft above river level. Although such estimates must generally be accepted with caution, the general form of this structure has been preserved in the spiral reliefs of the Trajan Column at Rome. This column depicts the achievements of the Emperor, and like the Forum Trajana, is also the work of Apollodorus.

According to tradition, this gifted Greek *architectus* met a violent end. Apparently over-proud of his skill and accomplishments, he is reported to have been too free and careless in his criticisms of the ideas of Trajan's successor, Hadrian. This was a fatal error, especially in view of the fact that Hadrian was himself a gifted *architectus*. Banished from Rome, Appolodorus is said to have been put to death in 109 A. D.

Lacer and the bridge at Alcantara

Spanning a rocky gorge in northern Spain, on the road to Portugal, one of the great works of Trajan's reign still stands despite the vicissitudes of time. It crosses the deep gorge of the Tagus River over 130 ft above the water but it is not exceptional either in length of spans or in overall length —627 ft. However in magnitude and in boldness of conception this bridge at Alcantara deserves to be ranked with the Pont du Gard, the bridge at Narni, and the Colosseum. Its high and massive piers reflect, as do these other works, the material power of a great nation of builders.

The center arches have span lengths of 90 and 94½ ft, and their height is 130 ft. The great height of the cutwaters on the piers indicates the remarkable flood heights this structure has successfully withstood for over 1800 years. One arch was destroyed by the Moors, then again during trouble with Portugal, and again by British forces in the Napoleonic Wars. Temporarily repaired in 1809 and in part demolished in 1836, the entire bridge was carefully restored in 1860, and it presumably still retains its original form.

This ancient work has an added, more human interest for the modern engineer since it marks one of those rare cases in which a Roman engineer succeeded in attaching his name to his work.

As was usual and officially proper, marble tablets were placed on the bridge dedicating it to Trajan and listing the towns which contributed funds for its construction. Although the engineer, Caius Julius Lacer, was unable to get his name on these tablets, he found another way to connect his name with a masterpiece of which he was naturally very proud. He achieved immortality by the simple expedient of building a small votive chapel at

Daringly slender piers and arches mark Spain's Aqueduct of Segovia, which was probably built a century later than Pont du Gard in Southern France. Segovia's Aqueduct, with its maximum height of over 100 ft and base width of only 8 ft, reflects a striking advance in structural understanding.

one end of the bridge—presumably at his own expense. Here he inscribed in rather poor Latin verse to be sure, an enduring record—all we know of the accomplishments of one C. J. Lacer, Roman engineer, and one of the few poets of whom the profession can boast. A translation of his poem is given under the accompanying photograph of the bridge. For this translation of the original (for which see the monumental *Corpus Inscriptionum Latinarum*, Vol. II, No. 759) I am indebted to my late colleague, Prof. LaRue VanHook.

The Aqueduct of Segovia

Unhappily no record, inscription, or poem remains to reveal the builder of one of the most daring of surviving Roman structures, the Aqueduct of Segovia. Under Augustus, as we have noted, attention was given to the development of Spanish cities and ports. Under Trajan, who was himself of Spanish origin, other notable works were undertaken. These probably included the famous viaduct of over fifty arches spanning the Guadiana at Mérida, the longest of Roman bridges, as well as the great Aqueduct of Segovia. Spain is in fact particularly rich in Roman works, although authoritative studies of many are lacking. A recent series of articles, sponsored by the Instituto Técnico de la Construccion y del Cemento, undertakes to supply this lack. Those on the Alcantara and Mérida bridges have already appeared. They are by Carlos Fernandez Casado, Engineer of Roads, Canals, and Harbors for the Spanish Government.

The aqueduct at Segovia, said to have been built in 100-115 A.D., is part of a 60-mile line which brought water to the city from the Guadarrama Mountains. It is some 2,700 ft long, has a maximum height reported at 119 ft, and includes only two levels, with tall slender piers supporting arches of about 15-ft span. Its sister work in Southern France, the Pont du Gard, is shorter but slightly higher, and far more massive. Compared with it, the slender, almost fragile construction of the Aqueduct of Segovia marks a notable advance in structural design. This daring "skeleton-stone" structure is an outstanding example of increased engineering skill springing solely from confidence gained through experience—in this case experience with stone, the major material of the day for such work. Any quantitative structural analysis or understanding of mechanics was of course lacking.

It is reported that, when the Napoleonic leader, Marshall Ney, first came upon this work he immediately noted that some thirty of the arches had been replaced in modern times. His comment was, "Here begins the work of men's hands."

Local legends attributing the building of bridges to the Evil One abound in Spain, and this aqueduct is one of the Devil's many bridges. According to our famous Secretary of State, John Hay (*Castilian Days*) the story runs:

"The Evil One was in love with a pretty girl of the upper town and full of protestations of his love. The fair Segovian listened to him one evening, when her plump arms ached with the work of bringing water from the Ravina, and promised with her eyes to favor him if his Infernal Majesty would build an aqueduct to her door before morning. He worked all night, like the devil, and the maiden, opening her black eyes at sunrise, saw him putting the last stone in the arch, as the first rays of the sun lighted on his shining tail. The Church, we think very unfairly, decided that he had failed, and released the coquettish contractor from her promise, and it is said that the devil has never trusted a Segovian out of his sight since."

(This story of engineering construction during the Roman Empire will be concluded in a subsequent issue.)

Report of Task Committee on Professional Education

Introduction

Carey H. Brown, Member, Board of Direction, and Board Contact Member of the Task Committee, Scottsville, N. Y.

As an introduction I wish to outline briefly the history of the Task Committee on Professional Education and the steps taken in reaching the conclusions and recommendations which appear at the end of the Committee's review and report. The various chapters of the report provide a perspective of the areas examined by the Committee; they also support the coordinated viewpoint expressed in the unanimously agreed upon 12-point Conclusions and Recommendations. The agreement resulting from study and discussion of views which originally were in some respects quite divergent, may be accepted as an indication of the soundness of the conclusions which were eventually reached.

Although the Conclusions and Recommendations have been presented to the Board of Direction for its information, the Board is not expected to take formal action until there has been an opportunity for the members of the Society to express their views. At this stage the Conclusions and Recommendations are those of the Committee.

Origin of Committee

The Task Committee was appointed by the Board of Direction of the Society in October 1953 (four years ago). It was designated originally as the Task Committee on Engineering Curricula, the purpose of its appointment being indicated by its name. Dean F. M. Dawson of the College of Engineering, State University of Iowa, who was then a member of the Society's Board of Direction, was apparently instrumental in having this Committee appointed and was the original Contact Member from the Board of Direction. The Task Committee has consisted of three practicing engineers, three educators and the Board Contact Member, as follows:

Adolph J. Ackerman, *Chairman*
Consulting Hydroelectric Engineer
Madison, Wis.

Harvey O. Banks, Director of Water Resources, State of Calif.
Sacramento, Calif.

Commodore C. P. Conrad (1953 to 1954)
Chairman of the Board
Iowa-Illinois Gas and Electric Co.
Davenport, Iowa

Admiral Kirby Smith, USN (Ret.) (from Jan. 1955), until recently Vice-President,
Raymond Concrete Pile Co.; New York
Associate, Roberts and Company,
Consulting Engineers, Atlanta, Ga.

Prof. F. B. Farquharson, Director, Engineering Experiment Station
University of Washington, Seattle

Dr. Nathan M. Newmark
Head, Dept. of Civil Eng.
University of Illinois
Urbana, Ill.

Dr. John B. Wilbur, Head, Dept. of Civil and Sanitary Eng.
Mass. Institute of Technology
Cambridge, Mass.

Composition of the Task Committee has remained constant during the four years of its activity except for the replacement of Commodore Conrad by Admiral Kirby Smith upon death of the former, and my appointment as Board Contact Member following the expiration of Dean Dawson's term as a Director of the Society. The geographical distribution and the wide range of professional experiences of the members of this Task Committee is noteworthy.

As a matter of organization, the Task Committee reports through the Department of Conditions of Practice as do various other Committees with professional assignments (as distinguished from the technical and administrative Committees).

Scope of assignment

At the meeting of the Society in Atlanta in February 1954, the scope of the Task Committee's assignment, namely, the study of engineering curricula, was somewhat extended, and subsequent actions by the Board of Direction have further broadened the field of inquiry, as will be evident from the final report.

The Committee was known for several years as the Task Committee on Engineering Education. The title was confusing to some since the Society has, as one of its regular professional groups, a standing Committee on Engineering Education. However the Task Committee recognized that its appointment was for a limited period and for the purpose of accomplishing a particular task. Furthermore, the standing committee has been represented at many of the Task Committee meetings, and I have been serving as Board Contact Member for both committees in the interest of coordination of effort. Recently the name of the Task Committee was changed to "Task Committee on Professional Education" to distinguish it more clearly from the Society's standing Committee on Engineering Education.

A first interim report was presented to the Board of Direction in New York in October 1954. In February 1955, a paper relating to the Task Committee's work was presented by Mr. Banks at the Society's San Diego Convention, and in June of the same year, papers by Mr. Ackerman and Professor Wilbur were presented at the St. Louis Convention. All three of these papers were subsequently published in CIVIL ENGINEERING.

Study of membership opinion

Practically from the beginning of the Task Committee's existence it was apparent that sound conclusions could be reached, or if entertained, could be verified, only after a survey had disclosed the facts with reference to a number of controversial questions. Consideration of the nature and extent of a survey, and its justification, have occupied a considerable part of the Task Committee's discussions.

At the time of the Dallas Convention in February 1956, the Task Committee had reached the conclusion that, as a first step in determining membership opinion and in more clearly defining the Committee's problem, an opinion poll by means of well-established sampling techniques should be undertaken. Such an opinion research cannot serve as a substitute for judgment, but is an *aid* in developing judgment. After examining the qualifications of Opinion Research Corporation in this field, the Task Committee concluded that the services of this organization should be engaged to undertake this assignment for the Committee.

At Dallas, therefore, the Task Committee requested the Board of Direction's approval for undertaking such an opinion research of the civil engineering profession. Meanwhile there had arisen in the Engineers Council for Professional Development a proposal that ECPD sponsor a comprehensive survey of the entire engineering profession and seek the approval and support of its participating societies, including ASCE and the other Founder Societies. The Board of Direction, naturally reluctant to take a step which might be construed to be contrary to the spirit of cooperation with the other participants in ECPD, postponed approval of the Task Committee's recommendation and requested that the Task Committee hold a joint meeting with the ASCE representatives in ECPD. This was done shortly after the Dallas Convention. There was full agreement that it was desirable that ASCE proceed with its own opinion research as recommended by the Task Committee.

In October 1956, at the Society's Annual Convention in Pittsburgh, the Board reappointed the Task Committee for another year and authorized it to conduct an opinion research with reference to civil engineers and the civil engineering profession. At the same time the Board authorized an appropriation to further the preliminary investigation

by others of a profession-wide survey as recommended by ECPD.

The Task Committee proceeded at once with Opinion Research representatives to define the scope and objectives of the proposed study. Chairman Ackerman had previously recommended that the opportunity for obtaining a sampling of ASCE membership opinion be extended to include questions of direct interest to the Society's Task Committee on Study of Economic Advancement Objectives. This was done to mutual advantage through participation by Mr. Lloyd Knapp, Chairman of that Committee, in preparation of certain sections of the questionnaire.

The findings from the opinion research have been assembled in a separate report* and have also been reproduced in the form of graphical charts. The results of four years' deliberations of the Committee, in which the opinion research served as a valuable aid in developing the judgment and conclusions of its members, are presented in the following pages.

Report of Task Committee on Professional Education†

I. Some Current Problems in the Civil Engineering Profession

Civil engineering deals with basic functions, such as construction, transportation, water supply and sanitation which are essential to the social and economic welfare of the country. Cutting across every sphere of human activities, it is more intimately associated with the business, health and well-being of the people than is any other branch of the engineering profession. It has, therefore, a great responsibility to society. The education and training of civil engineers should prepare them to meet this responsibility.

There is a decided shortage of civil engineers which shows no signs of abatement in the near future. The opportunities for satisfying careers in civil engineering are such that no young man who is interested in this field and who is qualified to enter it need have the slightest hesitancy in seeking to become a member of the civil engineering profession. Mr. Carlton Proctor, a Past President of the Society, has ably stated that "the opportunities for service and leadership by the truly professional man are without limit."

And what is a truly professional man? One of the best definitions was offered by the late Dr. Wickenden in an article, "The Second Mile." He listed four criteria as "the distinctive mark of the professional man":

"A type of activity which carries high individual responsibility and which applies special skill to problems, on a distinctly intellectual plane;

"A motive of service beyond that of mere profit;

"A motive of self-expression, which implies joy and pride in one's work and a self-imposed standard of excellence;

"A conscious recognition of social duty to be fulfilled."

In spite of the opportunities which a career in civil engineering has to offer, there appears to be a serious problem in attracting qualified young men into this field. While the number of students enrolled for their first degree in civil engineering has increased during the past five years, the rate of increase has been substantially lower than in any other major branch of the engineering profession.

During the past ten years civil engineering has lost its position as the branch of engineering which supplies the greatest percentage of deans in our engineering colleges. This seems to indicate that the relative importance of civil engineering as compared with other branches of engineering has lost ground in the eyes of top-level administrators of engineering colleges. Unhappily, the apparent loss in prestige of civil engineering is not limited to these top-level college administrators; it is shared by deans of engineering and even by an appreciable number of civil engineering department heads. Nor is it limited to engineering educators. Altogether too many practicing members of the civil engineering profession feel that other branches of engineering offer better opportunities and are held in higher regard by the public.

Public appraisal of the importance of civil engineering directly influences the entrance of qualified young men into the civil engineering profession. The first step in creating a more favorable public opinion of civil engineers is to engender a greater sense of pride and a more realistic feeling of importance among members of the profession itself. Instead of bemoaning the fact that in this age of spectacular scientific achievement we may not appear to be quite so scientific as some other branch of engineering, we should emphasize the positive fact that civil engineering plays a leading and indispensable role in assimilating technological advance into the culture of our society. Indeed, this demands quality and stature over and above the requirements of the analytical processes of scientific application. At this level civil engineering encompasses the more difficult professional responsibilities of harmonizing and integrating the conflicting forces of technological advances with the proper concepts of human values and ethics.

If the members of our Society wish to assist in either bringing more qualified men into the civil engineering profession or in improving the quality of engineering education, they must hold to a high professional attitude and be prepared to take an active and continuing part in achieving these ends. Among the steps which individual members can take are: (1) positive efforts toward interesting qualified young men in the field of civil engineering, (2) greater interest in student affairs, and (3) active support in seeking increased financing for good college faculties, buildings and equipment.

In addition to the efforts of the individual members, the Society as a whole must assist in the attainment of these objectives through: (1) counseling aimed at improvement in the broad goals of civil engineering education; (2) marshaling the influence of the Society behind efforts to secure needed funds from industry and from all other possible sources for the support and improvement of civil engineering education, and (3) making sure that the public is currently and fully informed of the activities and accomplishments of the civil engineering profession. One of the best ways to do this, according to the opinion of a large percentage of the membership, is to expand the existing Public Relations Division of the headquarters office (which has already initiated action in this direction). Consideration might be given, also, to the employment of one of the recognized public relation agencies which has special qualifications in building up a sound public attitude to the level merited by the civil engineering profession.

II. Some Facts about Civil Engineering Education

It would be easy, as well as pleasant, to paint a glowing picture of the status of civil engineering education today; and such an accounting would be based on a substantial number of solid facts. Today's faculties—the men upon whom the quality of this civil engineering education is largely dependent—are as dedicated to their task as were those of any earlier generation; indeed, in this era of economic squeeze on professorial salaries, high devotion to service in education must almost necessarily be involved, since otherwise it might be difficult to resist the more lucrative alternate of engineering practice. Furthermore, it is safe to say that most of our educational programs in civil engineering have never before been based more solidly on mathematics, on fundamental science, and on engineering applications of science—nor better integrated with research—nor more dedicated to the development of the creative abilities of our students. And certainly there has never been a greater demand for our civil engineering graduates.

But we shall not develop this theme. Quite to the contrary, we are presenting some facts that may be rather disquieting. This does not mean that we "view with alarm" the present status of civil engineering education but rather that we are anxious to see it prosper in every reasonable way; and critical appraisal may be a greater spur to further improvement than a basking in the warm glow of self-complacency. To this end, the following ten facts—or what are

*Copies for reference have been sent to all Local Sections.

†Presented at Annual Convention of ASCE, New York, Oct. 14, 1957.

believed to be facts—are presented about civil engineers and civil engineering education today.

Fact No. 1. Although the enrollment of undergraduate students in civil engineering is increasing, the increase is at a substantially lower rate than in the other major branches of the engineering profession.

Comment. In round numbers, civil engineering enrollment has increased 25 percent over the past five years. During the same interval, chemical and mechanical engineering have each increased by about 50 percent, while aeronautical and electrical engineering have each increased by about 100 percent.

The actual numbers of students enrolled for their first degree are shown in the following table: *

Year	Branch of Engineering				
	Aeronautical	Chemical	Civil	Electrical	Mechanical
'52	4,103	12,704	20,283	26,696	29,335
'53	4,869	13,429	20,882	30,916	31,390
'54	5,357	14,750	21,560	36,987	35,126
'55	6,326	16,698	23,784	45,835	39,691
'56	8,134	18,076	25,517	53,664	43,769

If, for each branch of engineering, the 1952 enrollment is taken as a base of 100 percent, the corresponding percentages for the other years of this period are as follows:

Year	Aeronautical	Chemical	Civil	Electrical	Mechanical
'52	100	100	100	100	100
'53	119	106	103	116	107
'54	131	116	106	138	120
'55	154	131	117	171	135
'56	198	142	126	201	149

While quality of students is perhaps more important than quantity, it is difficult to avoid the suspicion that the two are somewhat interdependent.

Fact No. 2. Although an appreciable number of the deans of our engineering schools are civil engineers, civil engineering has lost first place as the branch of engineering from which new deans are chosen.

Comment. This is of particular importance, not only because it may reflect the thinking of top-level college administrators as to the relative importance of the several branches, but because engineering deans influence budgetary as well as educational policies in engineering schools. Granted that deans administer their duties with every effort to be equitable, it would nevertheless seem inevitable that their honest convictions are influenced to some degree by the branch of engineering that has furnished the major background for their professional lives. The following table summarizes the changes in deans that have taken place during the past ten years. It is based on the list of institutional members of the American Society of Engineering Education as listed in the yearbooks of that society; schools in which no change of dean has occurred during the past ten years have been omitted so that the trend in selection of *new* deans would be pointed up.

*Source: Yearbooks, American Society for Engineering Education

Opinion Research among ASCE members and engineering educators (Charts 1-25)

CHART 1

Reasons for joining ASCE

1. Encouraged as a student to join
2. Prestige of membership
3. Keep up with technical developments
4. Contact with other engineers

CHART 2

Most important values in ASCE membership

	%
Publications	78
Local meetings	44
Professional status of membership	43
Meeting other members	38
Discussion of papers	9
Publication of my papers	5
Committee work	3

(From a list)

CHART 3

Society publications of most value

	%
Civil Engineering	84
Proceedings and journals	55
Manuals	10
Local Section publications	10
Other	5
Don't know	1

CHART 4

Readership of "Civil Engineering"

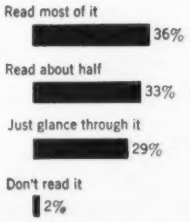


CHART 5

Evaluation of Society aims and objectives

	Have Done Good Job %	Need More Attention %
Technical publications	80	6
Promoting ethics	54	21
Local Section activities	38	19
Organizing conventions	36	2
Gaining public recognition	29	15
Promotion of registration	27	31
Improvement of education	27	34
Protecting members from forced union affiliation	23	23
Stimulating members to advance professionally	20	26
Raising member income	10	**51**

CHART 6

Should the Society devote more time and effort to improving fees, salaries and working conditions?

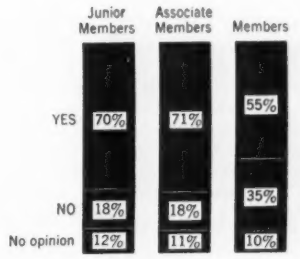


CHART 7

Would more direct efforts to improve members' economic welfare weaken the Society's professional status?

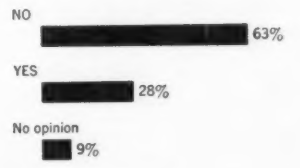
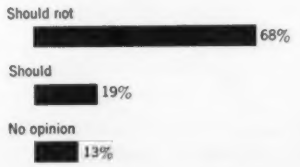


CHART 8

Should the Society support formation of local professional groups for collective bargaining?



Branch	1957		1948		Change in %
Aeronautical . .	1	(1.3%)	2	(2.4%)	+1.1
Chemical	6	(8.0%)	9	(11.0%)	+3.0
Civil	26	(34.7%)	21	(25.6%)	−9.1
Electrical	14	(18.7%)	16	(19.5%)	+0.8
Math. & Physics	4	(5.3%)	4	(4.9%)	−0.4
Mechanical . . .	19	(25.3%)	26	(31.7%)	+6.4
Miscellaneous . .	5	(6.7%)	4	(4.9%)	−1.8
Totals . . .	75	(100.0%)	82	(100.0%)	0.0

It will be noted that, on this basis, mechanical engineering has superseded civil engineering as the leading branch from which engineering deans are emerging.

Fact No. 3. Many civil engineers feel that the general public does not think that civil engineering is as important as other branches of the engineering profession. (Note: Data for this and for the following facts are based on the opinion survey conducted by the Opinion Research Corporation.)

Comment. Thirty-eight percent of the total membership of ASCE believe this to be true; only 18 percent believe that the public rates civil engineering as more important than the other branches. Among Junior Members, the corresponding percentages are 47 and 16 respectively, that is, nearly half of the Junior Members of ASCE feel that in the public view, civil engineering is not the most important branch of the profession.

Fact No. 4. Many civil engineers feel that civil engineering is not the best choice of an engineering profession.

Comment. Forty-six percent of the total membership of ASCE believe that some other branch is more promising; only 33 percent believe that civil engineering is one of the best. Among Junior Members the corresponding percentages are 48 and 30 respectively, that is, nearly half the Junior Members of ASCE feel that some branch other than civil is the most promising area of the engineering profession.

Fact No. 5. Some civil engineering department heads believe that civil engineering is not on the same footing among engineering college administrators as are other branches of the profession.

Comment. Although 78 percent of the department heads deny this, the view is held by 11 percent.

Fact No. 6. Not all civil engineering department heads and deans are optimistic about the future importance of civil engineering education as compared to the other branches.

Comment. Only 74 percent of the department heads are optimistic; and among deans, this figure is reduced to 56 percent. It may be startling to learn that apparently only about half of the deans of engineering in this country are definitely optimistic concerning the future importance of civil engineering education.

Fact No. 7. An appreciable number of civil engineering department heads and deans believe that civil engineering is the least promising branch for the future of students.

Comment. This is best summarized by the following two tables:

Most Promising	C. E. Dept. Heads	Deans
Same, no choice . .	55%	52%
Civil	26	4
Electrical	19	44
Mechanical	7	8
Chemical	4	20

Least Promising	C. E. Dept. Heads	Deans
Same, no choice . .	59%	60%
Civil	19	40
Electrical	15	0
Mechanical	7	0
Chemical	7	0

Note that the number of deans rating civil engineering as "least promising" outweighs those rating it as "most promising" by a ratio of ten to one. Note, too, that no field other than civil was rated by the deans as "least promising."

Fact No. 8. There is greater difficulty in attracting students to civil engineering than to the other branches.

Comment. This is believed by 67 percent of the civil engineering department heads and by 60 percent of the deans. Lack of promotion is blamed for this by 63 percent of the department heads and by 40 percent of the deans.

Fact No. 9. Most of the members of ASCE believe that the Society should place greater emphasis on public relations.

Comment. This view is shared by 69 percent of the total membership and opposed by only 17 percent. Among Junior Members, the corresponding percentages are 77 and 11 respectively.

Fact No. 10. The biggest problem facing engineering education today is that of providing adequate faculty salaries.

Comment. This is the opinion of 70 percent of the civil engineering department heads, and of 100 percent of the deans.

III. Summary of Membership Opinion with Respect to Civil Engineering Education

It is evident that the membership of the Society is seriously concerned about the adequacy of contemporary civil engineering education; less than half (47 percent) believe that recent civil engineering college graduates usually have the proper training to become successful civil engineers. More than one-third of the membership go so far as to state that the shortcomings are serious in nature; this concern is greatest among those who supervise recent graduates. (Chart 14)

Society members are concerned not only about inadequate technical education but about the broader aspects of the engineer's education, in fact they lay heavy emphasis on the need for better training in the arts of communication, human relations, and cultural matters. Many members believe, too, that the students should receive more training in the practical and business aspects of civil engineering. (Charts 15, 27)

The membership is strongly (66 percent) in favor of a five-year undergraduate program, with those most recently out of college voting more heavily (75 percent) in favor of the longer period of instruction than the older engineers.

Engineering educators, too, are not satisfied with the current educational process. Among the deans of engineering, 72 percent believe that there is urgent need for change in engineering curricula; 56 percent of the civil engineering department heads agree. There are, interestingly enough, some rather wide divergencies between the points of view expressed by the deans of engineering and those expressed by civil engineering department heads as regards needed curricula revisions. The deans appear to put much greater emphasis on the need for a stronger scientific background while the department heads lay more stress on the humanities, general cultural subjects, and the arts of communication. (Chart 28) Educators appear to be strongly in favor of maintaining the separate identity of the different branches of engineering education, although they are equally in agreement that at least half of the engineering courses offered engineering candidates should be the same for all branches. (Charts 29, 30)

With respect to civil engineering, 72 percent of the deans and 74 percent of the department heads agree that there is need for changes in civil engineering education. The deans are nearly unanimous in their opinion that civil engineers need the same training in mathematics and science as do students in the other branches. Two out of three department heads agree. In so far as desirable changes in civil engineering education are concerned, the deans vote strongly for more emphasis on more science and mathematics. The department heads agree that this is important but also stress the need for more emphasis on general education, human relations, and communication. The department heads are considerably more concerned about the development of creative ability than are the deans. The department heads are particularly conscious of the need for adequate grounding in the non-technical subjects.

In so far as their particular schools are concerned, 48 percent of both the deans and the department heads agree that they are doing a very good job in general education. Their views as to the adequacy of instruction in the humanities and arts of communication are not quite so optimistic; the department heads are particularly conscious of the shortcomings in these fields. (Chart 35) The principal reasons given for these inadequacies are lack of time, lack of student interest and faculty apathy. (Chart 36)

Whereas both deans and department heads are concerned over the lack of time under present curricula, 56 percent of the deans and 67 percent of the civil engineering department heads oppose a five-year curriculum for undergraduate study in civil engineering. This is in sharp contrast to the 66 percent of practicing ASCE members who favor the five-year curriculum. (Chart 37)

Only a small percentage of the educators interviewed believe that it is the responsibility of the engineering colleges to provide training in the practical and business side of engineering.

Engineering educators are deeply concerned over the problem of recruiting and holding high-quality teachers. They are also concerned over the inadequate preparation of entering students. Curriculum problems, lack of time, and lack of understanding between educators and industry as to curriculum content are likewise cited by many educators as major problems facing engineering education today. (Chart 26)

Throughout the report, the wide diversity of opinion between deans of engineering and civil engineering department heads on many matters vital to the civil engineering profession is apparent. (Charts 27 to 40)

Of the ASCE members interviewed, 34 percent believe that the Society should devote more attention to improvement of engineering education; this was one of the three principal activities mentioned in evaluation of the Society's Aims and Objectives. (Chart 5) Likewise 67 percent of the civil engineering department heads would like to see more Society activity in this field; 48 percent of the deans have no opinion on the matter. (Chart 40) Among the things that the Society might do, the educators list keeping the curriculum up to date, supporting better faculty salaries, enlisting financial support by industry, developing promotional materials for high school use and stimulating graduate programs. (Chart 41)

The results of the opinion survey sharply point up the educational problems facing the civil engineering profession today. Of particular significance are the diversities of opinion between the practicing engineers and the engineering educators and between the deans of engineering schools and the heads of civil engineering departments.

IV. Civil Engineering Curricula

With notably few exceptions the general program for engineering education has been limited to four years. During the period of tremendous expansion in the field of higher education, and in the face of the growth in the art and science of all professions, it is significant that the schools of engineering have generally retained the four-year curriculum, while the medical, architectural and legal professions have extended their educational programs.

The significance of the art in civil engineering

Recent discussions in the field of engineering education have led to the suggestion that "since the art cannot be taught with real effectiveness in college, we should place the technological emphasis of the curriculum upon engineering science instead." *

*"Education of Civil Engineers: Need for Reconsideration by," L. E. Grinter, M. ASCE, Proceedings Paper No. 858, Dec. 1955.

CHART 9

Collective bargaining for engineers?

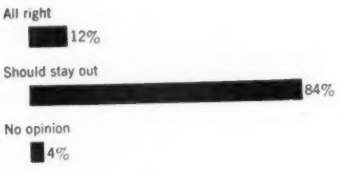


CHART 10

Will growth of collective bargaining undermine professional standing of engineers as a whole?

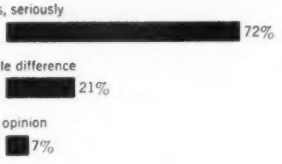


CHART 11

Engineers' estimate of public's regard for civil engineering

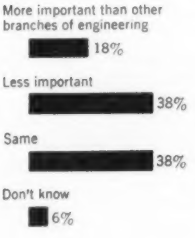


CHART 12

Support for increased public relations activity

	%
Favor establishing representation for the Society in Washington, D. C.	65
Favor increasing Society staff to step up local and national public relations	69

CHART 13

Distinguishing characteristics of civil engineering

	%
Broadest field, most comprehensive, not highly specialized	38
Concerned more with the practical, less with the theoretical, works are visible	24
More concerned with public welfare, deals with the advancement of human welfare	15
Oldest branch of engineering, parent of all engineering	6
More public contacts, more in the public eye	6
More connection with government than industry	6

(Chief mentions)

CHART 14

Adequacy of the civil engineer's college training

	%
Have proper training	47
Serious shortcomings in training	36
No opinion	17

CHART 15

Training needs:

1. More on the practical and business side
2. More on communication
3. Broader technical education
4. More liberal arts, humanities

CHART 16

Is civil engineering holding its own in the colleges?

	%
Getting smaller percentage of entering students	52
Same as in past	20
Larger percentage	6
Don't know	22

CHART 17

Member awareness of adequacy of high school science teaching in their community

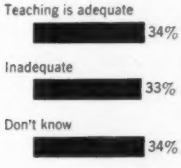


CHART 18

ASCE member activity in education and recruitment

	%
Have tried to interest young people in civil engineering as a career	44
Have given lectures or talks to students on professional experiences	24
Visited high schools to talk to students interested in civil engineering	11
Have had discussions with school authorities on improvement of high school science teaching	10

CHART 19

Attention given to national Society

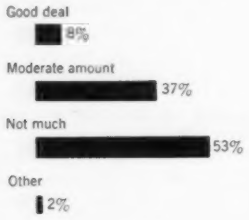


CHART 20

Attention given Local Section of Society

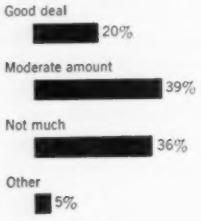


CHART 21

Participation in national Society meetings

	Junior Members %	Associate Members %	Members %
None in the last ten years	71	51	39
One or two	24	35	32
Three or more	4	14	29

CHART 22

Participation in Local Section meetings

	Junior Members %	Associate Members %	Members %
Not in the last twelve months	43	24	29
One or two	24	28	29
Three or four	17	15	23
Five or more	15	31	18

CHART 23

Professional activity of ASCE members

	%
Have held membership on Society local or national committees	28
Have held local or national office in ASCE	16
Have attended six or more Local Section meetings in the last year	17
Have attended five or more national Society meetings in the last ten years	5
Very active in community affairs	9

The profession of civil engineering, more than any other branch of engineering, deals with many diverse problems of society. It may be profitable to sketch the diversification in the civil engineer's field of practice:

1. The major portion of his effort falls in the public domain.

2. In the area of public works it often appears that the least of his problems is that of design. Before final detailed design procedure can be initiated, a number of factors must be considered, argued and often adjudicated in the following typical categories:

a) Possible clash of interest between elements of local, state, or federal government.

b) Financial feasibility as viewed by the bankers.

c) The impact of the proposed construction on the future expansion of the facility or the system of which it may be a part. Civil engineers often must look ahead as much as 100 years in justifying the manner in which they propose to build a segment of the total project, designed for immediate needs.

d) Civil engineers are generally to be found in the forefront of the negotiations involved in clearing these many hurdles.

The harmonizing of all of the conflicting interests involved in any great civil engineering project requires a broad understanding of the political, legal, business and human elements inherent in the situation.

Of equal scope and importance are the engineering sciences required in carrying out the final design. At some levels the situations involved are as frustrating as those arising at the socio-political level. Wind forces, earthquake hazards, foundation uncertainties, the unknown demands of the future and many other imponderables must be reasonably estimated.

There are no *exact* answers to such problems, but the judgment of the engineer, based on his education and experience, permits a rational solution. It is in this manner that the *art* of engineering is basic in arriving at a solution.

A recent paper has very cogently described this principal function of the truly professional man: "The engineer must have a firm base of systematized knowledge, but in professional practice such knowledge is only a background for most of the situations he will encounter; he must operate in areas that are in part above and beyond the well-documented but relatively limited areas of systematized knowledge. Perhaps the principal function of the truly professional man is to harmonize and relate the conflicting forces and tendencies that arise because of the very fact that the total systematizing of knowledge is an impossibility. Such a process of harmonizing and relating is not a science, but an *art* in the highest sense and if—in the name of professionalism—science be elevated to a point where the respectability of the *art* of engineering is substantially lost, the very essence of professionalism may likewise be lost in the process. . . .

"The pendulum of engineering education which, some years ago, had doubtless swung too far in the direction of engineering practice, seems now in danger of too much rebound into the realm of science. . . . We would not think for a moment of dropping the human values from engineering education; and we should guard the judgment values with an equal zeal."*

Since civil engineering education must not only teach an *applied science* but at the same time lay a foundation adequate for eventual proficiency in a dominant *art* which is more rigorous than that required in most other branches of engineering, it would seem that the qualifications for *professionalism* are somewhat more demanding in this field.

Broad requirements of a professional civil engineering curriculum

Early in its deliberations the Task Committee addressed itself to the problem of the most effective curriculum for the education of the professional civil engineer, giving consideration not only to conditions of the present but also to the increasingly complex problems which the civil engineer will face in the future. However, it soon became evident that there is no single adequate answer. There are good reasons for this situation:

1. Civil engineering covers a wide range of fields. Different schools emphasize different parts of the whole. No single pattern is adequate to serve either the needs of every school or the requirements of all civil engineers.

*"An Excursion Through Exactitudes," by John B. Wilbur, a paper presented at the annual meeting of ASEE, at Cornell, June 1957. (*Journal of Eng. Educ.*, Dec. 1957)

CHART 24

Attention given to EJC

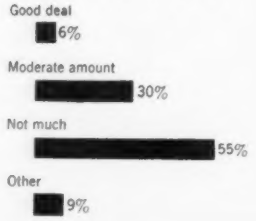
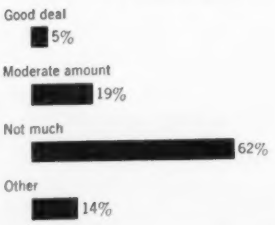


CHART 25

Attention given to ECPD



2. There are major differences of opinion among civil engineers, both within and outside the teaching profession, as to the relative importance in the educational program of the scientific background, the humanistic-social stem, and the art of the profession. These differences were reflected in the viewpoints of the members of the Task Committee.

3. Previous studies by competent groups, the most recent being the ASEE Committee on Evaluation of Engineering Curricula, have met with almost complete indifference in some cases, or with strong condemnation in others. In either case the result is nearly total inaction, and even the better parts of these reports have had little effect on civil engineering education.

4. Civil engineering is in a rapidly growing and changing era. New technical advances and new tools and methods change the problems with which the practitioner is faced. Where the pattern of the future is obscure, variety and even experimentation are necessary. Four- and five-year programs, cooperative and regular in-school curricula, scientifically oriented and practically oriented courses—each has its advantages and each has its weaknesses. It is clear only that a fixed pattern in these matters is not desirable.

Summary

The general diversity of the outlook of the profession was reflected in the initial views of the individual members of the Task Committee. But it is noteworthy that the mutual discussion and interchange of ideas in the progress of the work of the committee have led to a remarkable unanimity in the conclusions we present here as the result of our effort:

1. The civil engineer is a professional man, and he must be trained as such. He must therefore have an understanding of the society he lives in and of his fellow man. He must be able to envisage and plan the whole of a project in consideration of its economic structure and utility, its sociological impact, and its technical details. He must be able to present his ideas effectively and to defend them. It is essential, therefore, that he have a good general education with an understanding of the social sciences and humanities, and a facility in the arts of communication of ideas. To enable the student to derive full benefit from such subjects, he must be made to realize their importance to him, not only as an individual, but as an engineer.

2. Mathematics and the physical sciences are fundamental to civil engineering. Training in these sciences, and application of their principles, are essential in the curriculum.

3. Judgment and a sense of proportion have especial significance to the civil engineer. Development of these characteristics is perhaps the most important aim of the entire curriculum. We have no easy answer as to how this can be done. Yet a program which does not give adequate consideration to these qualities will not be a successful educational program for civil engineering. Courses in the area of application of basic principles can be used to develop these characteristics. However, a primary need is capable teachers with proper professional training themselves.

4. The integration of planning, experience and design functions, together with the physical and social aspects of the problem, into the final objective of the engineer is the most difficult thing to teach. It is here that the civil engineer differs most from the practicing engineer in other fields, and at this level his education must be especially strengthened.

5. It is apparent that there is already too much to be covered in a four-year program, or possibly even in a five-year program under present concepts and methods. Therefore an effort must be made to weed out the non-essentials, to avoid needless repetition, and to find more effective means of teaching and of combining or coordinating the various aspects of the curriculum. The Task Committee feels that experimentation in curriculum content and teaching methods must be encouraged.

6. For the more effective utilization of the limited available time the curriculum could, to advantage, be integrated with a training program in engineering practice which is designed to extend into the first years after graduation. The growth and maturing of professional qualities must be stimulated by organizations employing civil engineers. Such organizations should be encouraged to institute adequate in-service training programs.

7. A further means of training in the art of engineering and in professional practice lies in the increased use of professional engineers as volunteer lecturers before junior and senior design classes. In addition periodic senior seminars might be conducted with some outstanding local engineer in attendance at each meeting. These regular contacts with the profession would be most stimulating to the students and faculty, and would serve the equally important function of bringing a broader group of the Society's membership into intimate contact with the problems of engineering education.

8. The demands of the curriculum make it clear that only able and intelligent students with a good secondary and high school background will be able to cover the work successfully. Those with less ability should be directed into a terminal program where they can be trained to work as technical aides, rather than as professional engineers. Development and expansion of such terminal programs should be encouraged to meet the rapidly increasing need for subprofessional assistants and technicians.

9. Finally, the gifted individual should have special attention. The student with unusual aptitude should be sought out early, encouraged to go further, and given a training which both challenges and stimulates him. Whether his interest be in research, in planning and design, in construction, or in teaching, the potential leader will add luster to the profession. He must be cultivated.

In view of the overwhelming endorsement for an *extension* of the civil engineering curriculum which has been expressed by our membership through the opinion survey, attention by the Society becomes imperative. The members speak out of their experience and deserve an answer.

As is evident from the summary of member opinion on the curriculum, the membership, especially as represented by the younger man, has reflected dissatisfaction with some elements of their education.

Basic civil engineering education should encourage and develop to the maximum possible extent professional attitudes and attributes such as creative ability, judgment, ethical standards, curiosity and the desire to serve.

Therefore it is suggested that the professional civil engineering curriculum of the future be built within the outline shown in Table I. In view of remarks under "Broad Requirements" it would be presumptuous to lay down a rigid curriculum in civil engineering. Table I breaks the curriculum down into seven categories in the belief that every item listed is of importance to the civil engineer. The specifics of each category and the sequence are left to the indi-

TABLE I

Suggested curriculum for undergraduate civil engineering

I. General education: History, literature, sociology, philosophy, ethics, human relations, political science.

II. Means and arts in communication of ideas: The written and spoken word, graphics, design drawing.

III. Economics, finance, law: General economics, financing and legal background common to civil engineering problems.

IV. Basic science: Mathematics through ordinary differential equations; chemistry, including physical; physics, including nuclear and solid state.

V. Engineering science: Mechanics of solids (statics, dynamics, strength of materials), fluid mechanics, thermodynamics, electrical theory, properties of materials (theoretical and practical).

VI. Engineering art and method: Cultivation of knowledge and judgment through the solution of specific engineering problems both simple and complex, including the relationship to the physical and social environment.

VII. Elective flexibility: Provision for the addition of other sciences and nontechnical subjects, including languages, of peculiar interest to certain divisions of civil engineering.

vidual civil engineering department. Every effort should be made to achieve a balanced curriculum without undue emphasis on any one aspect.

Of equal importance to the curriculum is the professional caliber of the faculty. It is imperative that a considerable proportion of the faculty be composed of men of *broad professional experience*. In the selection of a teaching faculty, emphasis should be placed on teaching ability, as well as on research orientation and ability, and on professional experience.

Admittedly all this is a large order and will require both time and money in large amounts. However it is imperative that the civil engineering profession begin now to redefine and reorient the educational process to meet the needs of the present and the challenge of the future. Improvement in the quality of professional education is the essential first step in enhancement of professional status.

V. The Position of ASCE in Civil Engineering Education

This section is concerned with what the American Society of Civil Engineers can and should do with regard to civil engineering education. That the members should be interested in this topic is an assumption which follows from the concept of the civil engineer as a professional man. But it follows that the individual civil engineer must do more than be interested in education; he must also take an active part in the training of others to follow in his profession. Civil engineering department heads feel that the Society does not give enough attention to engineering education, as shown in Chart 40.

Unfortunately, the members of ASCE play far too passive a role in engineering education. They are not themselves enthusiastic about their profession; nearly half of them, as shown in Chart 11 for example, feel that other fields are more promising. This view is shared by too many of the educators, as shown by Charts 31 and 32. The opinion research among the members indicates that many of them are more concerned with what they can gain from the profession rather than what they can give to it and, through it, to the public welfare. Only 15 percent of the members recognize this obligation, as shown in Chart 13. Before the Society can become a positive force in education, its members must convince themselves of the value of their work and of the importance of their profession to the future of humanity.

How can a change in the attitude of the members of ASCE be achieved? This is the basic problem confronting the civil engineering profession. It cannot be achieved by recommendations and resolutions from the leaders of the Society. It can be accomplished only through the intensive efforts of the individual members acting in groups at local levels. It can be assisted by the Society's Board of Direction and through its senior committees on policy and coordination of effort. But above all it requires an acceptance by each member of the Society of his role as a professional, and an assumption of the duties and responsibilities of that role.

With strong support from active Local Sections and individual members, the Society, both directly and through its influence on industry, governmental agencies, legislators, consulting firms, and individual engineers can take effective action in a number of specific ways to support and strengthen civil engineering education in the United States. These ways are the following:

1. Recognize and make it clear to others that professional training is a continuing process in which experience is gained and judgment is strengthened and matured by practice, based on the fundamental scientific training supplied by the colleges. A four- or even a five-year college program can give only the general educational and the technical basis for professional training. The internship and the learning-by-doing must come from association with practicing engineers. The supervising engineer must accept his responsibility for the development of the young engineers under his direction. Demands from industry or consulting firms that engineers be thoroughly trained as technical aides when they report for their first job are impossible to meet without sacrificing other vital aspects of their education in professional responsibilities. Industry, as well as the practicing engineer, has an obligation to help the graduate obtain the balance of his professional training.

2. By proper use of technicians and subprofessional assistants, make the professional engineer more productive and give him a better opportunity to become effective in the overall planning functions which are the mark of his profession. The use of mechanical or electronic computation and data processing can relieve the professional man of much tedious routine and give him more time to think and plan.

3. By exerting influence on industry and the general public, develop a broad base of financial support for civil engineering education. In both public and private educational institutions, teachers are underpaid, buildings and equipment are in short supply, many good students cannot afford a college education, and fundamental research funds are not sufficient. Grants in aid, gifts, increased legislative appropriations, industry-wide allocations from profits, and similar means can supply the necessary financial assistance. Civil engineering educators can seek additional funds, but they need help by the creation of a favorable atmosphere or "climate of opinion" which can come only by effort on the part of the whole profession. The needs of civil engineering, in particular, need to be impressed on university administrators, state legislators, local industries, and other groups.

4. Help civil engineering teachers to obtain a broad professional training in practice. This can be done by devising programs to bring the teacher into contact with practice on leaves of absence or through summer work. Since he may not be able to earn a suitable salary in such short-term employment, some help from industry may be necessary. On the other hand, to further strengthen the teaching program, practicing engineers must assist by bringing to the classrooms the benefit of their experience, in clinical lectures and short courses.

5. Influence bright and able young men to go into civil engineering as a profession. This requires more intensive and individual effort than has been expended heretofore to bring to their attention the opportunities in our profession, including especially the opportunities for the advancement of human welfare. Financial help in the form of part-time employment, scholarships, and loan funds will be needed to provide a college education for many of the prospective engineers who should have one. Personal contacts with high school students are required to select the appropriate men and to influence them in the proper direction. These comments are supported by the opinion poll, Charts 16, 33 and 34.

6. Hold periodic meetings of Local Sections devoted entirely to the subject of civil engineering education. Participation in these meetings by educators is essential. Efforts should be made to obtain a presentation and evaluation of the various conflicting points of view regarding engineering education. By this means, members can arrive at conclusions based on all the evidence and avoid being misled by the minority who are unwilling to accept change in the requirements of a civil engineer's education. Chart 15 shows that the members of the Society have definite views on the needs of education. With guidance, cooperative action by, and positive support from the local members, the educator's job of planning and carrying out his plans will become materially easier. The initiative for such cooperation can come from the schools or from the Local Sections. However, to insure that each does not wait for the other, the Society should coordinate the program through its Committee on Conditions of Practice.

7. At the local level, and with the cooperation of the engineering schools develop plans and programs for additional training and further education of young engineers in practice. Education does not stop with graduation from college. The Society already does a great deal in this respect through its technical publications. However, it can do more. The members feel that the Society's publications are its more important values. This is indicated by Chart 2.

8. At the Local Section level, take an interest in secondary school education to the end that beginning students may enter civil engineering colleges with better preparation. Meetings of Local Sections devoted to this problem, and committees of civil engineers working cooperatively with officials and teachers

of local school systems, are needed on a continuing basis.

These ways in which ASCE can help engineering education are in accord with expressed views of the educators, as shown in Chart 41.

To summarize, the ASCE at all levels, from the Local Sections to the Board of Direction, should cooperate with educators: (*a*) in defining the objectives, the scope, and the requirements of professional education in civil engineering; and (*b*), in the diligent pursuit of means of achieving the objectives and of fulfilling the requirements.

First in importance is the urgent necessity of greatly increased financial support for civil engineering. The responsibility for providing this support rests on all those connected with the profession: the construction industry, material suppliers, equipment manufacturers, and practicing engineers. Support from these sources is desperately needed for adequate faculty salaries, increased financial aid to students, proper facilities and equipment for instruction and research, and buildings and laboratories in which to teach. All members of the Society can help effectively and their help is needed immediately.

VI. Basic Problems in Sponsoring Corrective Measures

Since its appointment by the Board of Direction in October 1953, the Task Committee on Professional Education has held a total of 12 formal meetings. The fact that the Committee has remained unchanged in membership throughout the past four years, with one exception, was especially valuable in maintaining a continuity of effort and in developing a common understanding of objectives. The Committee was determined to avoid making a limited or "out-of-context" study of a stratum called "engineering education." It was evident at an early stage that this subject required examination within the full spectrum of our professional organization, its nature, its strength, its weaknesses, its cohesiveness, its responsiveness, its capacity to mobilize action, and its ability to adopt and implement desirable objectives.

At the Convention of the American Society of Civil Engineers in St. Louis, June 15, 1955, a progress report describing the work of the Task Committee was presented in the paper, "Engineering Education—an Appraisal." At that stage it was assumed that a sound basis on which to chart a course for the future could be developed by means of an "engineering approach" to the problem, namely, by first gathering the facts, and then drawing conclusions and presenting recommendations. This "gathering of the facts" was visualized in terms of a "comprehensive survey and analysis of the civil engineering profession with particular reference to the problems in civil engineering education."

It was recognized that considerable time and money would be required to undertake such a survey; however, there

Opinion Research among engineering educators (Charts 26-41)

CHART 26

Main problems confronting engineering education

1. Getting and holding enough quality teachers
2. Keeping curricula up to date
3. Inadequate high school preparation of students

CHART 27

Is there urgent need for curricula changes in engineering education?

	Dept. Heads %	Eng. Deans %
Yes	56	72
No	44	28

CHART 28

Curricula changes

	Dept. Heads %	Eng. Deans %
More stress on the humanities	22	8
Bring course content up to date	19	28
More basic sciences	19	36
Modernize teaching techniques	15	20

(Chief mentions)

CHART 29

Maintain separate identity for different branches of undergraduate engineering education?

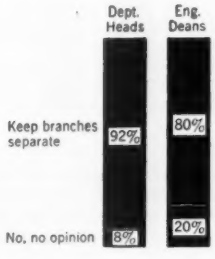


CHART 30

How much uniformity in engineering curriculum?

	Dept. Heads %	Eng. Deans %
Half or more of the courses should be same for all branches	89	88
Less than half	11	8
No opinion	0	4

CHART 31

Most promising branches of engineering today

	Dept. Heads %	Eng. Deans %
Civil	26	4
Electrical	19	44
Mechanical	7	8
Chemical	4	20
Same, no choice	55	52

CHART 32

Least promising branches of engineering

	Dept. Heads %	Eng. Deans %
Civil	19	40
Electrical	15	0
Mechanical	7	0
Chemical	7	0
Same, no choice	59	60

CHART 33

Why civil loses students to other branches of engineering

Other branches do more in promoting career glamor

Salary inducements better in other branches

Course materials in civil less interesting

CHART 34

How to attract more students to civil engineering

1. More aggressive public relations; publicize its attractions as a career
2. Explain and dramatize its values to students at the high school level
3. Back higher salaries in government and industry for civil engineers

CHART 35

Do civil engineering students get a good grounding in the nontechnical?

Very good in:	Dept. Heads %	Eng. Deans %
General education	48	48
Humanities	33	44
Arts of communication	22	32

were reasons to believe that the necessary financing might be obtained from one of the endowed foundations, provided an acceptable statement of justification could be presented to its board of directors.

New studies by the Task Committee

After the St. Louis Convention, the Task Committee undertook the development of a specific program for a comprehensive survey; it also initiated studies of the feasibility of communicating the final conclusions to the membership and of implementing the recommendations which eventually were expected to emerge from the proposed survey. In the course of these studies the members of the Task Committee not only contributed valuable judgments, but they also respected the occasional challenge and minority view which appeared from time to time in such questions as: "Why do it?", "What will you accomplish?", and "How will you accomplish it?"

As a result the Task Committee has gained considerable insight on the problems of conducting a comprehensive survey and on the limitations of a professional society in attempting to develop a broad program of corrective measures. These experiences and observations have been a valuable guide for the Committee; it is equally important that the members of the Society examine for themselves some of the basic problems in promoting desirable objectives, or corrective measures, which would contribute to the advancement of the profession.

Unrealistic estimate of a survey's accomplishments

We have found that a fundamental limitation is our own self-confidence, supported by the tendency toward oversimplification, and by the idea of applying our traditional engineering approach to a basically social problem. Instead of presuming that we can appraise such a complex human organization as the civil engineering profession, and that we can formulate a program which would produce desirable improvements within a reasonably short period of time, it behooves us, first of all, to develop a realistic perspective.

We need to reemphasize the fact that progress is largely the result of persistent, undramatic daily work, directed toward agreed, realizable, limited objectives. How to accomplish this within available abilities and means—under normal conditions—this is the task. The persistent initiative and cooperative effort must come from many quarters: from the leaders among engineers and businessmen, college administrators and faculties, taxpayers and donors, public officials and boards of directors.

Past examples of general surveys

A common device in our usual professional approach is to examine previous experience. In the paper presented in St. Louis, a report on the medical profession was cited as an example of successful application of the survey technique. By implication it appeared that the preparation of a suitable report, distributed to all members of our profession, would be the most effective means of rapidly mobilizing corrective measures in our own profession. However, members of the medical profession have pointed out that their survey was made many years ago, at a time when the profession was relatively small, and when a very bad professional situation existed which was ripe for public disclosure; this immediately produced corrective measures on a broad base.

It is apparent that today we are not confronted with this type of problem. Our problems are more deep-seated, involving inflationary pressures on faculty incomes, lethargy and indifference on the part of a large percentage of the Society's membership, and similar conditions which call for an entirely different approach.

The problems currently confronting the medical profession are, in general, as great as ours, and yet the leaders of that profession have concluded that they did not require a comprehensive survey and report to define them. Instead, the medical profession has concluded that *education of the next generation of its profession* is its most important problem. For the solution of this problem a collective effort has been mobilized on a very large scale.

As a further example of experience in other professions, we have examined the activities of the American Bar Association in conducting a comprehensive survey of the legal profession. The survey of that profession, conducted from 1947 to 1952, has required large expenditures, plus contributions of a great amount of professional time. However, in the final analysis, the results have not come up

CHART 36

Why civil engineers don't get broader education

	Dept. Heads %	Eng. Deans %
Overburdened teaching staff; lack of time	63	57
Student apathy	29	14
Teaching standards are low	17	24
Inadequate pre-college training	8	24

CHART 37

Extend civil engineering undergraduate study to five years?

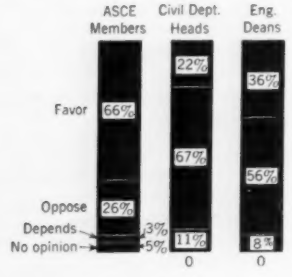


CHART 38

Importance of these in civil engineering vs. other branches of engineering

More important in civil:	Dept. Heads %	Eng. Deans %
Facility in writing & speaking	67	20
Perspective on total problems	67	28
Judgment	63	36
A sense for the practical	63	40
Skill in human relations	63	40
Ability to make decisions	52	44
Administrative ability	52	28
Ability to work on a team	41	32
Creativity	33	8
Intuition	29	16
Scientific knowledge	9	8

CHART 39

Relative importance given civil engineering education by college administrators

	Civil Eng. Dept. Heads %
Civil engineering given same importance as other branches of engineering	78
Less importance	11
More importance	0
No opinion	11

CHART 40

Attention ASCE gives to engineering education

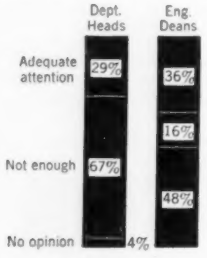


CHART 41

What engineering educators say ASCE can do for civil engineering education

Assist educators in keeping curriculum up to date

Financial support for advanced study

Support better pay for teachers, alert industry to colleges' financial needs

Closer liaison with teacher members of ASCE

Continue and expand public relations efforts

Develop promotional materials for high schools

Target more ASCE services and promotion to students

(Chief mentions)

to expectations. When the question was raised with one of the leaders in the legal profession he stated, "I regret to say that I know of no currently measurable results."

Problems of financing a comprehensive survey

The endowed foundations have a great responsibility in selecting worthy causes which should receive gifts or financial support, and in appraising the potential benefit from such gifts. By the same token, the applicants for such support have the responsibility of demonstrating that the proposed expenditures will produce a measurable result of sufficient importance to justify the cost. An evaluation of the returns on such an investment calls for evidence of the feasibility of implementing the findings, and of developing measurable attainments. The Task Committee has found no acceptable basis for predicting adequate returns from an investment in a comprehensive survey.

Communication and implementation of survey findings

The engineering literature carries a considerable number of professional papers and studies on basic problems in our profession. However, the principal difficulty is the fact that engineers are too busy to read the wealth of information which is currently available to them and which is of direct concern to the welfare of their profession. Most of the members of the Society tend to "leave such problems for someone else to work out." This fact indicates that the heart of the problem is, first, communication of important recommendations to the members and, second, mobilization of their support in the implementation of such recommendations.

Unfortunately too many of our members feel that "the Society" should assume the responsibility, and most of the initiative, for developing corrective measures, but they fail to examine the limitations of such a concept. The majority of the members are neglecting their obligations to their profession. They tend to "leave it to others" to develop basic policies and to administer future objectives, without realizing that such an attitude contributes to a general weakening of the engineering profession.

A new type of survey technique

A useful type of survey technique was found which was helpful in developing judgment on problems of the profession; this consisted of an "opinion research" among the members of the Society, whereby membership attitudes on basic problems, and on proposed corrective measures, were tested by sampling representative opinion. Professional services in this field were employed by the Task Committee with excellent results.

Membership opinions were gathered by interviewers located in various cities throughout the country. Each interviewer was equipped with a questionnaire which had been developed by the Task Committee in cooperation with officials of the research organization; by this means opinions were gathered from a representative portion of our Society's members. Separate opinions were also assembled from the deans of engineering and from the heads of civil engineering departments in a representative group of colleges, including large and small institutions, both privately and publicly owned.

The low cost of this opinion research, about 6 percent of the expense originally visualized, is of special interest. Such an opinion research gives results which are within a probable error of 5 or 6 percent. The findings cannot be regarded as a substitute for judgment, but served as an aid in developing the judgment of the Task Committee.

Results of opinion research

The accompanying charts indicate significant facts concerning the attitudes of our members and concerning the limitations found in the general organization of our Society. Most of the findings emphasize the need for developing greater activity at the local level.

Chart 2 summarizes what the members consider the most important values in ASCE membership. Publications are obviously considered of greatest importance. Personal participation and individual initiative on the part of the members is indicated as being of importance to only 3 percent in terms of committee work, and to only 5 percent in terms of publication of members' papers. Less than half the membership attaches importance to such features as local meetings, professional status of membership, and opportunity to meet other members.

Charts 3 and 4 indicate the relatively high interest of members in reading CIVIL ENGINEERING, with 69 percent reading more than half of it.

As indicated in Chart 20, only 20 percent of the members give a good deal of attention to the Society at the Local Section level. This is extremely low, particularly when it is considered that effective action on the part of the Society must be initiated at the local level.

In Chart 22 the participation in Local Section meetings is again indicated to be extremely low, particularly in terms of the members attending less than three meetings during the past twelve months. This low attendance record applies to 58 percent of the Members, 52 percent of the Associate Members, and 67 percent of the Junior Members. About half of these groups have attended no Local Section meetings.

In Charts 17 and 18 the low personal participation and initiative of the individual members are again indicated. Only 11 percent of the members have visited high schools to talk to students interested in civil engineering, and only 10 percent have had discussions with school authorities on improving high school science teaching.

As indicated in Chart 23, only 9 percent of the members are very active in community affairs, and only 5 percent have attended five or more national meetings in the past ten years.

Chart 21 indicates that only 14 percent of the Associate Members and only 29 percent of the Members have attended three or more national Society meetings in the past ten years. Granted that considerable expense is involved in attending such meetings, it should be noted that the national meetings are carefully located to reach a broad base of membership in all parts of the country at least once every two years.

According to the findings summarized in Chart 19, only 8 percent of the members give a good deal of attention to the national Society. A similar result was found in the case of another professional society where only 7 percent of the members indicated a similar degree of interest.

Chart 24 indicates that only 6 percent of the members give a good deal of attention to Engineers Joint Council, whereas 64 percent give little or no attention to this activity. Similarly Chart 25 indicates that only 5 percent of the members give a good deal of attention to Engineers Council for Professional Development; 76 percent give little or no attention to this activity.

It is interesting to note from Chart 40 that, in general, more than two-thirds of the educators in civil engineering are of the opinion that the American Society of Civil Engineers is not giving enough attention to engineering education. In this respect the support at the local level is of paramount importance.

It is significant from Chart 6 that a substantial majority of the members feel that the Society should devote more time and effort to improving fees, salaries and working conditions, although this is contrary to the primary objectives and responsibilities of the Society.

Summary

This opinion research has confirmed the fact that the great majority of the members of our profession are too busy with their daily responsibilities, or are not sufficiently interested, to devote themselves to the broader problems relating to the welfare of their profession. In some quarters this has been referred to as "the general lethargy." There is a clear indication that it is very difficult to communicate important matters in this area to the individual member, and it is even more difficult to mobilize him into action for implementing the recommendations, no matter how important they may be.

Challenge to the profession

One of the sharpest challenges was bequeathed to the present generation of engineers by the late Dean Mortimer E. Cooley, Hon. M. ASCE, of the University of Michigan. In his eighty-eighth year he was persuaded to write his autobiography, *Scientific Blacksmith* (ASME, 1947), in which he stated:

"For too many years the engineer has been limited or has limited himself, to the making of the physical environment out of which have sprung the thoughts and actions of others. The engineer has played a passive part. He has been con-

tent in his field of applied science; in fact he has gone to sleep on the job. He has been asleep nearly as long as Rip Van Winkle. . . . As matters now stand, the engineer creates the problem of his accomplishments, yet leaves the solution to the economist, the politician, and the statesman, who understand none of the technical phases of the problem. . . . The engineer must be educated to the needed changes in his training which will enable him to take over the responsibilities of leadership that, by virtue of this technical civilization, are so largely his."

Responsibilities of the professional man

The by-laws of the American Society of Civil Engineers state that the Board of Direction shall "take measures to advance the profession of engineering and the interests of the Society." However, national events of the past few decades have influenced many members to the view that the Society should concern itself with the advancement of their own professional status and welfare. (Charts 7, 8, 9 and 10)

It is traditional, particularly among members of the engineering profession, that each man has the primary responsibility with respect to his own professional progress and welfare. The Task Committee's findings show that the *obligations of the individual* in our profession are repeatedly emphasized. At this stage each member owes it to himself to reexamine his responsibilities towards himself and towards his profession. The strength of the American Society of Civil Engineers can increase only as the individual member contributes to its development, particularly at the local level.

A thought for the future

The civil engineering profession is founded on a rich heritage of achievement and service to the public welfare, and in this fact every civil engineer can find a source of great pride and inspiration. Although the Task Committee has chosen to emphasize current shortcomings and weaknesses in our profession, it has done so in the belief that, given the facts, the members of the American Society of Civil Engineers will respond most effectively in meeting their professional responsibilities.

Many years ago one of our country's great leaders, President Theodore Roosevelt, had this to say:

"It is not the critic who counts; not the man who points out how the strong man stumbled, or where the doer of deeds could have done them better.

"The credit belongs to the man who is actually in the arena; whose face is marred by dust, sweat, and blood; who strives valiantly; who errs and comes up short time and again; who knows the great enthusiasms, the great devotions, and spends himself in a worthy cause; and who at the best knows in the end the triumphs of high achievement; and who at the worst, if he fails, at least fails while daring greatly, so that his place shall never be with those cold and timid souls who know neither defeat nor victory."

VII. Conclusions and Recommendations*

Conclusion 1. Civil engineering has certain characteristics which distinguish it from the engineering profession as a whole. Among these are breadth of field and the responsibility for economic planning, greater concern with public works and with countless structures serving the public welfare, and the development of plans and programs extending far into the future.

Recommendation. Although certain undergraduate courses are commonly required for all students in engineering, civil engineering curricula must maintain their separate identity and objectives and the civil engineering departments of our colleges should receive support consistent with the civil engineer's great contribution to society.

Conclusion 2. Because of the inability to meet the prevailing competition from other employers of engineers, the engineering colleges are experiencing great difficulty in attracting and holding teachers of high quality, particularly in the younger age groups.

Recommendation. The American Society of Civil Engineers should promote the provision of adequate salaries and emoluments for teachers, as well as the raising of funds which are needed to hold and develop competent faculties. The Local Sections must accept a major responsibility in this matter.

Conclusion 3. In the field of civil engineering there is a widespread feeling among educators and practicing engineers that present civil engineering curricula are in need of change. Engineering progress and the resulting pressure for adding new courses emphasizes the impossibility of uniform adherence to the four-year undergraduate curriculum as now generally offered. Engineering is now the only important profession which is generally adhering to the four-year period of undergraduate study. A substantial part of the membership of the American Society of Civil Engineers favors an increase in the period of instruction.

Recommendation. In order to provide the extent and type of professional training demanded, the American Society of Civil Engineers must cooperate in the development of educational programs and curricula applicable to the status and needs of the various educational institutions. Such programs call for increased emphasis on postgraduate training, extension of the time devoted to undergraduate training, evening courses for employed engineers, self-education of various types, and clinical lectures and discussions by practicing engineers. Standardization of the length of the undergraduate curriculum is not recommended since the period of undergraduate study, by itself, is not a measure of adequacy of engineering education.

Conclusion 4. The plans and designs of the civil engineer are largely translated into reality by the construction industry, and many civil engineering graduates make their careers in that industry. A cooperative committee of the American Society of Civil Engineers and the Associated General Contractors of America has been established and some of the Local Sections are developing cooperative programs in engineering education.

Recommendation. The American Society of Civil Engineers should give greater attention to the needs of the construction industry and to the development of programs whereby the Society and the engineering colleges may better serve the industry.

Conclusion 5. There is a prevalent feeling that the achievements of civil engineers deserve greater public recognition.

Recommendation. The American Society of Civil Engineers should encourage greater effort in public relations at the national level, as well as on the part of Local Sections. Desirable forms of publicity would help to foster a justifiable pride in the profession, and would stimulate the interest of the younger members and students.

Conclusion 6. There is a distinct shortage of civil engineers. The enrollment of students is not keeping pace with future requirements, and the attraction of qualified young men into civil engineering is a serious problem.

Recommendation. The American Society of Civil Engineers must intensify and expand its efforts in attracting young men to the profession. The responsibility of Local Sections and of individual members in this respect must be accentuated.

Conclusion 7. While the shortage of engineers has, no doubt, resulted in improved utilization of qualified men in the profession, widespread opinion persists that the present practices in the use of available engineering manpower and resources are not efficient.

Recommendation. The American Society of Civil Engineers should concern itself more with the problems of initial employment of graduates and with the harmful effects of "hoarding" young engineers. Likewise, it should encourage the training of engineering aides and technicians, and the provision of more clerical, technical and mechanical assistance to engineers.

Conclusion 8. Many of the members believe that attention of the American Society of Civil Engineers to their economic welfare is a proper function of the Society; however a large proportion of the members holds a contrary view.

Recommendation. The economic welfare of members of the Society should receive continuing attention, but it must be borne in mind that the primary objective of the Society, and of engineering education, is the development of professional ability and ethical attitude of its members.

Conclusion 9. A major proportion of the Society's membership maintains that professional standing would be seriously undermined by organizing for collective bargaining.

*Presented to Board of Direction at Annual Convention, New York, Oct. 21, 1957.

Recommendation. In the education and training of young engineers in professional attitudes, the inconsistency between collective bargaining and professional status must be emphasized.

Conclusion 10. The participation of civil engineers in their professional Society and in community affairs leaves much to be desired.

Recommendation. Through its Local Sections the American Society of Civil Engineers should encourage greater participation and individual activity in community affairs, including, in particular, interest in the local school system and in the encouragement of qualified young men to enter the civil engineering profession. At the Local Section meetings on community affairs or on education, public officials or local educators should be invited to participate. Special emphasis should be placed upon Local Section committees on public affairs, on precollege education, and on vocational guidance. In this connection the publications of Engineers' Council for Professional Development will be found very helpful.

Conclusion 11. The membership in general considers the Society publications, particularly CIVIL ENGINEERING, very effective.

Recommendation. CIVIL ENGINEERING, the Journals, and other publications must continue to receive the capable effort and the financial support now accorded them. In addition to the engineering descriptions, it is desirable that these technical articles record more generally the economic justification, means of financing, and the public policies involved, to inform readers, and students in particular, on these aspects of civil engineering practice.

Conclusion 12. The Task Committee on Professional Education has found, from a study of a great amount of published information and from a test of membership opinion, an adequate basis for developing its conclusions and recommendations.

Recommendation. The Task Committee on Professional Education withdraws its former recommendation for a comprehensive survey of the civil engineering profession, in the belief that such a survey is unwarranted and would disclose no further substantial basis for action. Instead, it recommends that each Local Section organize a permanent Committee on Professional Education with sufficient tenure to assure that the important responsibilities referred to above are accepted and successfully implemented.

Respectfully submitted,

TASK COMMITTEE ON PROFESSIONAL EDUCATION

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Harvey O. Banks
Prof. Frederick B. Farquharson
Prof. Nathan M. Newmark
Rear Adm. Kirby Smith, C.E.C. USN (Ret.)
Prof. John B. Wilbur
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ENGINEERS' NOTEBOOK

Adjustable forms for 149 bridge columns

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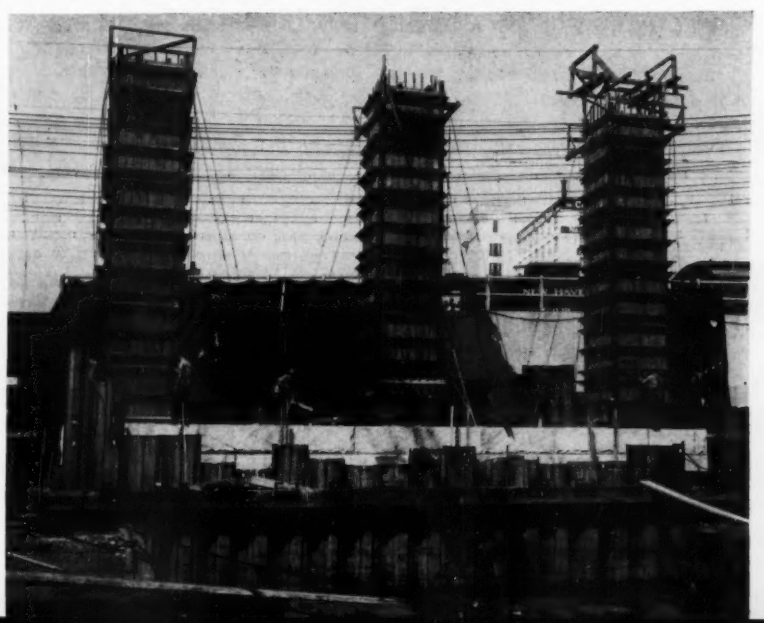
Obtaining simple, uniform, and economical forms is the heart of any large-scale concreting operation. On the Bridgeport Harbor Bridge, part of the Connecticut Turnpike, a particularly troublesome form problem was presented by the design of the reinforced concrete columns which support the steel superstructure. (See article by A. S. Wikstrom, A.M. ASCE, in the September 1957 CIVIL ENGINEERING, p. 64.)

There are 149 of these columns, which range in height from 25 to 54 ft. Generally they were to be placed in two lifts, the lower lift ranging in height from 10 to 30 ft, and the upper one being either 22 or 24 ft. The width in the plane of the cap was constant. The challenge lay in the two sides of the columns, which were to be battered 1 on 48. The top widths of the battered sides lack only a few inches of being alike. However, the bottom width as well as the height varies, so that no two columns have exactly the same dimensions.

To overcome this difficulty, two types of form were built, one for the relatively uniform top lifts and another for the highly variable lower lifts. No internal ties were feasible because of the heavy reinforcing. To simplify procedure, each form was set and stripped as a unit. A form was never disassembled throughout its period of use but it could be adjusted to the different dimensions required.

The lower-lift form was constructed so that one side could be adjusted to the various widths, as shown in Fig. 1. The wales consisted of channel sections varying from 8 in. to 4 in., depending on concrete pressure. To these

Adjustable forms are seen in place on three columns for Bridgeport Harbor crossing on Connecticut Turnpike. No two of the 149 columns for this crossing have same dimensions, although all have two sides battered 1 on 48.



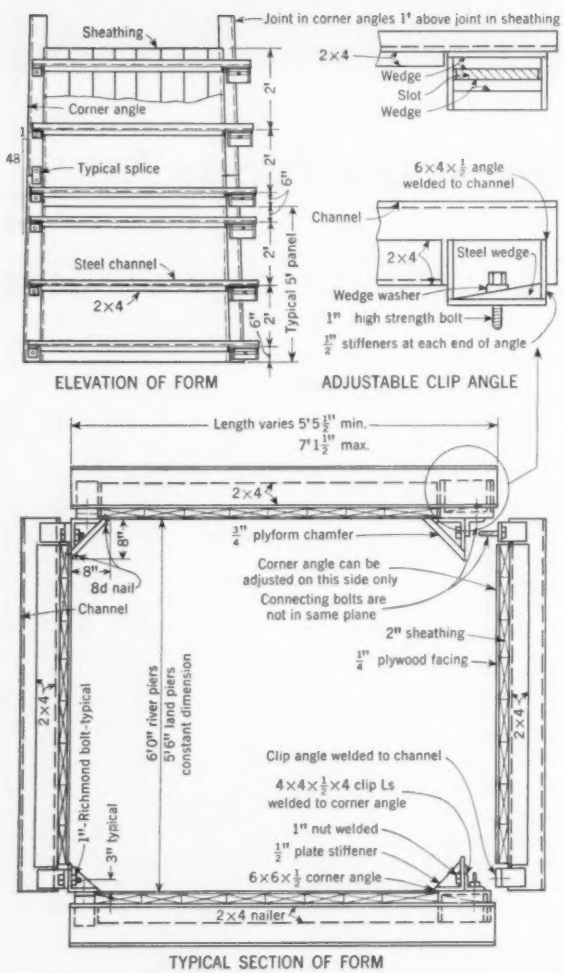


FIG. 1. Lower form for columns has adjustable side which can be moved in or out by means of slotted clip angles while bolts remain in place. Clip angles are connected to corner angle, but connecting bolts in corners are not in the same plane. To strip form, bolts in three corners are loosened.

a 2 × 4 was fastened with a Ramset gun. The 2 × 4 acted as a nailing surface for the 2-in. sheathing, which was faced with ¼-in. plywood. The wales were generally on 2-ft centers, bolted at each end through clip angles with a 1-in. Richmond lag-threaded bolt to vertical corner angles, 6 × 6 × ½ in. The nuts were welded to the inside of the corner angles, and the bolts were loosened or tightened but never removed.

The lower-lift form was built so that one battered side and the two vertical sides would remain in place while the other battered side would be adjusted in or out as required. This was accomplished by slotting the clip angles on one end of the vertical side wales and welding a wedge at each side of the slot. For this connection a 1-in. high-strength bolt was used, with a cast-iron wedge washer acting against the wedges on the clip angle.

When a form was to be adjusted, it was set on its side, with the adjustable panel in a vertical position. The bolts were loosened and the adjustable panel was moved into position with sledge hammers. This was accomplished by two men in about four hours, the time of course depending on the amount of adjustment required. It was found in practice that a few uprights placed inside the form to relieve the pressure of the top side on the adjustable side greatly aided the operation. After adjustment, the bolts were tightened, and the internal pressure was resisted by wedge action.

The lower form was built in 5-ft sections, with the joint in the corner angle differing by 1 ft from the joint in the panels. Thus the lower wale of each panel was attached to the corner angle of the panel below. Splice plates connected the corner angles at the joints, making a completely rigid form. The maximum adjustment in width was 6 in. Thus, for columns that varied too widely in height and width, a 5-ft section had to be either added or removed as the case might be. This was done simply by four bolts that connected the corner angles at the joint, one at each corner.

Placing of chamfer and V-groove strips, oiling and tightening of bolts were done while the form lay on its side on the ground. After the reinforcing steel had been set, the form was lowered over it with a crane. To strip, the bolts were loosened on three corners of the form, which was then jacked from the top of the pour to break the bond, and lifted off, again as a unit, by the crane. Power impact wrenches were used for all bolting.

The top form was constructed like the lower one except that it was not adjustable. It was 28 ft in height and made up in two sections, which remained joined as one unit. The wales were placed on 2-ft centers throughout. Inserts were placed near the top of the first pour at a predetermined height, and a work scaffold was placed after the lower lift had been stripped. The top form was then set with the lower bolts loose so that it could pass over the existing concrete and rest on the scaffold. After the lower bolts had been tightened and the form tied down, it was ready for concrete. Stripping was similar to that for the lower form.

Scaffolds for workmen concreting the column were prefabricated and bolted to the corner angles at the top of the form.

Columns were designed to withstand a rise of concrete of 20 ft per hour or a pressure of 1,700 psf for winter concreting. The maximum rate of rise achieved on the job was 17 ft per hour. No major troubles were encountered in using each form 13 times. The ¼-in. plywood facing, although oiled each time, had to be sanded at the joints periodically. But it stood up very well. However, it would have been better to use ⅝-in. or ¾-in. plywood as a facing for better wearing qualities, and to cut down the sheathing to ⅝-in.

These forms proved to be highly successful because of the ease with which they could be set and stripped. Although a form for one lift weighed about 6 tons, it was easy to handle because it remained in one piece. Contractor for the job was A. S. Wikstrom, Inc. of Skaneateles, N. Y.

Section modulus of structural members quickly found

SAMUEL J. LEVINE, Civil Engineer, Engineer Research and Development Laboratories, Corps of Engineers, U. S. Army, Fort Belvoir, Va.

About twenty years ago a group of bridge engineers convened to devise a simple method for quickly computing the live-load capacities of highway bridges from a few simple bridge measurements. For this purpose several equations were devised for rapidly finding the approximate section modulus of various types of structural members.

To replace these several equations, the writer has devised one simple general equation, Equation 1, for computing the approximate section modulus for all types of symmetrical structural members.

$$Z_a = d_w\left(A_f + \frac{A_w}{6}\right) + cA_v \quad . \quad . \quad (1)$$

in which

Z_a = gross or net approximate section modulus of structural member (in.³)
A_f = gross or net area of tension flange or bottom chord of truss (in.²)
A_w = area of web or webs of structural member (in.²)
A_v = sum of auxiliary tension areas parallel to the web (in.²)
d_w = depth of web (in.)
c = distance toe to toe of auxiliary tension areas (in.)

This equation provides a fine degree of accuracy for an approximate section modulus value.

Except in the case of plate and angle girders (Fig. 1), Eq. 1 is further simplified for some types of structural members as shown in Eqs. 1(*a*), 1(*b*), and 1 (c) of Figs. 2, 3, and 4. The gross or net section modulus of a structural member can be computed by substituting for A_f in Eq. 1, the gross or net area value, respectively, of the tension flange of the member under consideration, as shown.

The general types of structural members are shown in Figs. 1, 2, 3, and 4, with their corresponding approximate section modulus formula in simplified form where applicable.

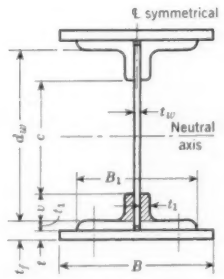


FIG. 1. A plate girder.

$$Z_a = d_w\left(A_f + \frac{A_w}{6}\right) + cA_v \quad . \quad . \quad . \quad \text{Eq. 1}$$

$A_f = Bt + B_1t_1$; $A_w = d_wt_w$; $A_v = 2t_1v$

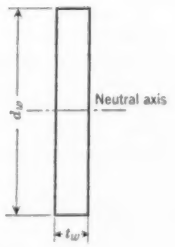


FIG. 2. A rectangular section.

$$Z_a = d_w\frac{A_w}{6} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{Eq. 1}(a)$$

$A_f = 0$; $A_w = d_wt_w$; $A_v = 0$

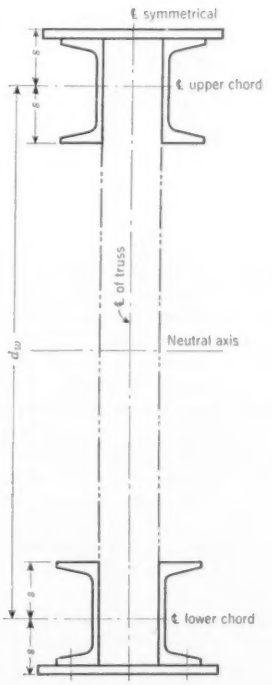


FIG. 4. A truss.

$$Z_a = d_wA_f \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{Eq. 1}(c)$$

A_f = Area of tension chord for any type of assembly

$A_w = 0$; $A_v = 0$

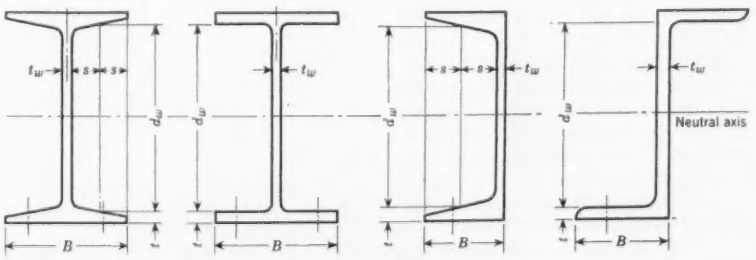


FIG. 3. Rolled sections.

$$Z_a = d_w\left(A_f + \frac{A_w}{6}\right) \quad . \quad . \quad , \quad \text{Eq. 1(b).} \qquad A_f = Bt;\ A_w = d_wt_w;\ A_v = 0$$

Inverted stepped footings for savings with safety

PAUL ROGERS, M.ASCE, Paul Rogers & Associates, Consulting Engineers, Chicago, Ill.

Present practice in designing individual spread footings usually calls for a square or rectangular reinforced concrete slab of uniform thickness on which the column is placed directly. The American Concrete Institute Building Code 318-56 prescribes in detail the procedure to be followed in order to obtain the proper design values for bending moments, shear for bond, and shear for diagonal tension. Since this is an established design procedure, it is assumed here that the reader is familiar with Chapter 12 of the ACI Code.

Although this design method is easy to apply, it has two major shortcomings. To satisfy the relatively low allowable shear values, the footing has, as a rule, a greater thickness than is needed for flexure. But even this increased thickness is seldom adequate to develop the full working value of the column dowels through bond. Pedestals between the footings and columns are usually objectionable, since they create obstacles in usable floor area, and also add considerably to the cost of form work.

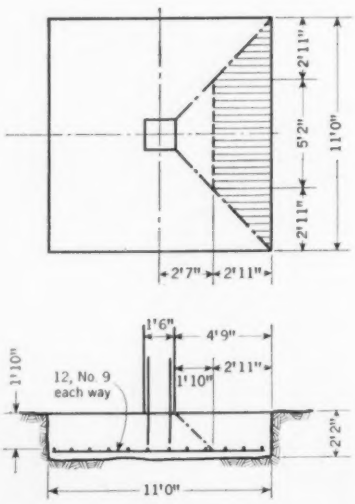
It is suggested that instead of providing a pedestal above the footing slab, a depression be made *below* the footing. As compared with footings of uniform thickness, this system has numerous advantages, such as:

1. The thickness of the main footing can be considerably reduced.
2. The depressed area below the footing can be easily excavated. Extreme accuracy is not required, and there is no objection to crumbled edges.
3. The total thickness below the column can be easily selected to satisfy the requirements for bond of the column dowels.
4. There is a very substantial saving in steel reinforcing, concrete, and excavation.
5. Shear and bond stresses are reduced considerably.
6. Such a footing gives added strength to resist sliding.

Two comparative examples have been worked out, one using a conventional spread footing, and the other a depressed pedestal. The column load is 437 kips; column dimensions are 18 in. square with spiral reinforcing; vertical bars are 7 No. 11 hard-grade steel; the maximum allowable soil pressure is 4 kips per sq ft; f'_c for the footing is 2,500 psi.

f_c = 1,125 psi; v = 75 psi; u = 200 psi for footing bars; and u = 250 psi for dowels.

FIG. 1. Conventional footing



Conventional footing

The conventional footing (Fig. 1) consists of a reinforced concrete slab 11 ft 0 in. square and 26 in. thick. The weight of this slab is 40 kips, and the actual soil pressure is

$$\frac{437 + 40}{11^2} = 3.94 \text{ kips per sq ft}$$

The soil pressure producing stresses is

$$\frac{437}{11^2} = 3.62 \text{ kips per sq ft}$$

The trapezoidal shaded area indicates the shear force to be used as a measure of diagonal tension. Thus

$$V = 8.08 \times 2.92 \times 3.62 = 85.3 \text{ kips}$$

$$v = \frac{85{,}300}{5.16 \times 12 \times 0.87 \times 22} = 71 \text{ psi}$$

$$M = 11 \times 4.75 \times 2.38 \times 3.62 = 450 \text{ ft-kips}$$

The rectangular area, comprising the width from the face of the column to the edge of the footing times the length of the footing, indicates the shear force to be used for computations of bond stresses. According to the ACI Code, only 85 percent of this

value is to be used for the selection of reinforcing. Thus

$$V_u = 11 \times 4.75 \times 0.85 \times 3.62 = 161 \text{ kips}$$

$$\Sigma_o = \frac{161}{0.87 \times 22 \times 0.200} = 42 \text{ in.}$$

$$A_s = \frac{450 \times 0.85}{1.44 \times 22} = 12.1 \text{ in.}^2$$

$$\frac{\Sigma_o}{A_s} = \frac{42}{12.1} = 3.47$$

Use 12 No. 9 bars each way.

Check bond stresses in dowels. Total force in 7 No. 11 column bars is:

$$10.92 \times 20 = 218 \text{ kips.}$$

Total perimeter required to develop bond is:

$$\frac{218}{0.25 \times 23} = 37.9 \text{ in.}$$

Then 9 No. 11 dowels are needed, which is two extra dowels over the seven required for the column bars.

Estimated quantities for the conventional method are:

Concrete:

$$11^2 \times 2.17/27 = 9.8 \text{ cu yd}$$

Reinforcing steel:

$$24 \times 3.4 \times 10.5 = 858 \text{ lb}$$

Two additional dowels:

$$2 \times 5.31 \times 4.4 = 47 \text{ lb}$$

$$905/2{,}000 = 0.452 \text{ tons}$$

Inverted stepped footing

The inverted stepped footing (Fig. 2) consists of a reinforced concrete slab 11 ft 0 in. square and 18 in. thick, plus a depression 6 ft 0 in. square and 16 in. thick. The weight of this footing is 34.4 kips, and the actual soil pressure is

$$\frac{437 + 34.4}{11^2} = 3.90 \text{ kips per sq ft.}$$

Soil pressure producing stresses is

$$\frac{437}{11^2} = 3.62 \text{ kips per sq ft.}$$

The larger trapezoidal area indicates the shear force for the thickened portion to be used as a measure of diagonal tension.

$$V_1 = 8.5 \times 2.5 \times 3.62 = 76.8 \text{ kips}$$

$$v_1 = \frac{76{,}800}{6 \times 12 \times 0.87 \times 27} = 45.5 \text{ psi}$$

The smaller trapezoidal area indicates the shear force for the thinner portion to be used as a measure for diagonal tension.

$$V_2 = 9.67 \times 1.33 \times 3.62 = 46.5 \text{ kips}$$

$$v_2 = \frac{46{,}500}{8.33 \times 12 \times 0.87 \times 14} = 38.2 \text{ psi}$$

M_{max} at face of column is

$$M_1 = 11 \times 4.75 \times 2.38 \times 3.62 = 450 \text{ ft-kips}$$

85 percent of 450 = 382 ft-kips

$$d \text{ required} = \sqrt{\frac{450}{11 \times 0.196}} = \sqrt{209} = 14.5 \text{ in.}$$

d furnished = 34 − 4 = 30 in.

$$A_{s\,min} = 0.0025 \times 30 \times 11 = 8.3 \text{ sq in.}$$

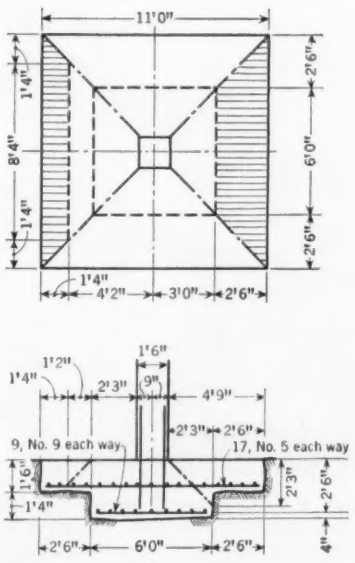
$$A_s = \frac{382}{1.44 \times 30} = 8.8 \text{ sq in. Use this.}$$

Shear for bond is

$$V_{u1} = 11 \times 4.75 \times 3.62 \times 0.85 = 161 \text{ kips}$$

$$\Sigma_{o1} = \frac{161}{0.87 \times 30 \times 0.200} = 31 \text{ in.}$$

FIG. 2. Footing with depressed pedestal



$$\frac{\Sigma_{o1}}{A_{s1}} = \frac{31}{8.8} = 3.5.$$

Use 9 No. 9 bars each way.

At the edge of the depressed pedestal,

$$V_{u2} = 11 \times 2.5 \times 3.62 \times 0.85 = 84.6 \text{ kips}$$

$$\Sigma_{o2} = \frac{84.6}{0.87 \times 14.5 \times 0.200} = 33.5 \text{ in.}$$

$$M_2 = 11 \times 2.5 \times 3.62 \times 1.25 = 124.5 \text{ ft-kips}$$

85 percent of 124.5 = 106 ft-kips

$$d \text{ required} = \sqrt{\frac{124.5}{11 \times 0.196}} = \sqrt{57.8} = 7.6 \text{ in.}$$

d furnished = 18 − 3.5 = 14.5 in.

$$A_{s2} = \frac{106}{1.44 \times 14.5} = 5.08 \text{ sq in.}$$

Use this.

$$A_{s2\,min} = 11 \times 14.5 \times 0.0025 = 3.98 \text{ sq in.}$$

$$\frac{\Sigma_{o2}}{A_{s2}} = \frac{33.5}{5.08} = 6.6.$$

Use 17 No. 5 bars each way.

Check bond stresses for 7 No. 11 dowels:

$$u = \frac{21{,}800}{30 \times 31} = 234 \text{ psi}$$

Estimated quantities for the inverted stepped footing are:

Concrete: $11^2 \times 1.5 = 181.5$
$6^2 \times 1.33 = 48.0$
$229.5/27 = 8.5$ cu yd

Reinforcing: $18 \times 3.4 \times 5.5 = 336$ lb

Steel: $34 \times 1.043 \times 10.5 = 373$ lb

$709/2000 = 0.355$ tons

A comparison between the conventional footing and the one with a depressed pedestal shows, in favor of the latter, a saving of steel of 21.5 percent, and a saving of concrete and excavation of 13 percent, which is very substantial. It is of importance, however, that the shear stresses have been reduced by 36 percent and 44 percent respectively, and the column dowels can develop the required bond stresses without additional bars.

It is believed that this type of footing can bring about considerable savings and reduce internal stresses, while keeping construction methods simple.

SOCIETY NEWS

Program Set for ASCE Convention in Chicago

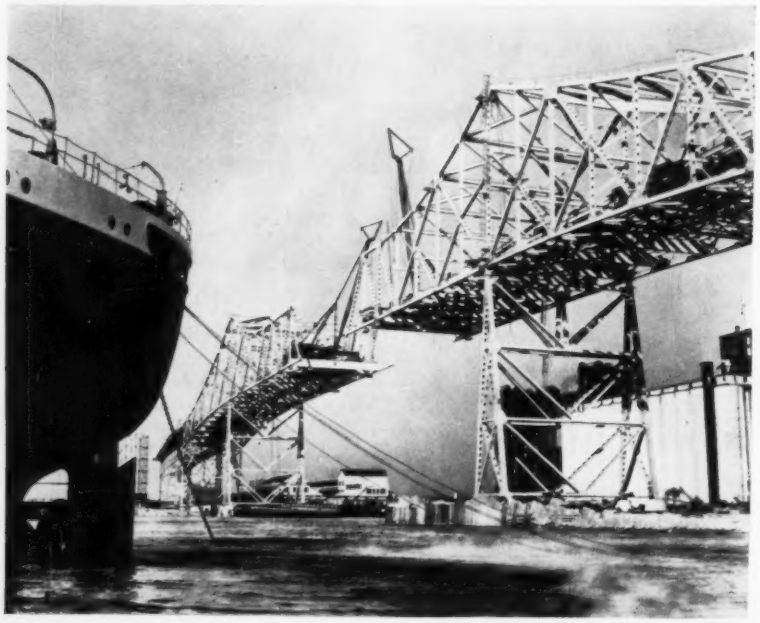
Engineering achievements and problems of the Midwest area dominate the themes of papers scheduled for the Society's Chicago Convention to be held at the Hotel Sherman, February 24-28. But while the vast building and construction program of the Central States is naturally highlighted, the Convention program also offers many papers appealing to a wide choice of engineering interests as well as a good share geared to the interest of the general public. The long list of speakers and subjects appeared in full in the January issue.

A local project under close study at the Convention will be the city's airport construction program. Also featured will be the new Calumet Skyway —slated for completion sometime this year—which will speed traffic from the Indiana Toll Road into the heart of the city. The development of Indiana Harbor is the subject of a paper to be presented at a session of the Waterways and Harbors Division, at which papers on the Port of Chicago and the scientific advances in river equipment will also be given. Chicago's $50,000,000 parking problem is up for discussion, too.

The Hydraulics Division will offer papers on Lake Ontario evaporation as well as on the hydrology of Lake Ontario and the currents and water masses of Lake Michigan. At a Surveying and Mapping Division session there will be survey reports on the Illinois and Michigan Canal Property, the Richard I. Bong Air Force Base, and the Mackinac Bridge.

Nuclear power problems the engineer must solve will receive considerable attention at the meeting. One session will be devoted exclusively to the general subject of the structural aspects of nuclear reactor design, while another will cover civil engineering aspects of the local Dresden Nuclear Power Plant and design of its spherical containment shell. Incidentally, the Dresden Nuclear Power Plant is on the circuit of Convention tours.

New in Convention history and of interest to all will be an Electronic Computer Demonstration, an all-day show, Monday through Thursday, put on by five of the companies that supply computer equipment. A list of civil engineering programs has been selected for the demonstration, so that visitors can see and understand what the computer is doing. It will be a unique opportunity to observe and compare different computers in operation. More about the electronic computer program planned for the Convention is given in the Structural Division's account of its Convention sessions, which follows this item.



Objective of one of the Convention field trips is the Calumet Skyway, which will take through traffic from the Indiana Toll Road into the center of the city. Here the Skyway crosses the Calumet River.

On the Tour Agenda

A number of trips of more than passing interest have been arranged to projects in the Chicago area. In addition to the chance to see the Dresden Nuclear Power Plant, tours have been arranged to such public works developments as the Central District Filtration Plant, the Congress Street Expressway, the Calumet Skyway Bridge, and the city's parking facilities. The Pipeline Division will conduct an all-day field trip to the Joliet Measuring Station and the Herscher Storage Field.

All who have seen the complete program in the January issue must realize that everything possible has been done to assure a successful Convention at both technical program and social level. All you need to do to get your share is be there!

Structural Division Plans Ambitious Convention Program

Electronic Computation Session

The Structural Division's new Committee on Electronic Computation has arranged a general Monday afternoon session to brief engineers on the use of a new and powerful tool.

John J. Kozak, of the California Division of Highways, will introduce the electronic computers as engineering tools by describing their application to structural engineering problems. John P. Nash, of the Lockheed Aircraft Corp., who has acted as consultant on the design of several high-speed digital computers, will discuss the characteristics of this type of computer and tell in simple terms how it works. H. A. Radzikowski, chief of development for the Bureau of Public Roads, in a talk on "Development and Integration of Electronic Computation Into Highway Engineering Operations," will describe the programs that have been prepared and show how they can help the engineer's work. A panel discussion will conclude the session. In view of the wide interest in the committee's work, it is expected that this discussion will be very popular.

With the nuclear power reactor here to stay, civil engineers are urged to avail themselves of the program on structural aspects of nuclear reactor design planned for Tuesday afternoon, February 25. The session will be the Division's first venture into the nuclear field. The four papers planned have been made general enough to serve as an introduction to the uninitiated engineer, but not too general to be useful to those who have been designing in the field.

Nuclear Reactor Design

The speakers, all authorities in the field, are John F. Stolz, supervisor of engineering design of reactor facilities, Atomics International Division, North American Aviation, Inc., Canoga Park, Calif., whose subject will be "General Considerations of Reactors and Related Plant Types;" John Zickel, stress analysis engineer, Power Reactor Engineering, General Electric Company, San Jose, Calif., who will discuss "Stress Analysis in the Design of Nuclear Power Plants;" B. John Garrick, chief nuclear scientist, Holmes & Narver, Inc., Los Angeles, Calif., whose topic is "Some Problems Associated with Construction of Radiation Barriers in a Reactor Plant;" and Gibson Morris, chief engineer, Engineering Department, Oak Ridge National Laboratory, Oak Ridge, Tenn., who will speak on "Construction Techniques and Design Considerations."

Chicago—a great metropolitan development on a lakefront of surpassing beauty—is the nation's No. 1 Convention city.

Joint Session with the ACI

Not since the ASCE Centennial Convention in Chicago in 1952 has there been an opportunity to arrange a joint session of the Society's Structural Division and the American Concrete Institute. Again this year, fortunately, the Institute and the Society are holding their conventions simultaneously in Chicago. There was such great interest in the joint sessions on concrete during the Centennial that another joint session has been planned.

The meeting will take place on Wednesday afternoon, February 26, in the Grand Ballroom at the Morrison Hotel, where the ACI Convention will be in progress. P. D. Miesenhelder, research engineer, concrete, for the Association of American Railroads, will lead off with a paper on a most important subject, "Influence of Design and Details of Structures on Concrete Deterioration." All too often, when deterioration of concrete is observed, it is considered due to inferior material. Such a conclusion is confusing, when other portions of the structure are found to be in excellent condition and when, furthermore, it is obvious that the two portions were of the same materials and placed at the same time. After study of a great number of structures in different localities, built of different materials and in different years, it becomes apparent that there is a similarity in the portions affected and in the conditions existing at those places. The conditions result directly from design of the structure. Mr. Miesenhelder's paper will point up causes and effects and show how attention to design and details will improve performance.

The shear strength of reinforced concrete has been studied exhaustively during the past decade in an effort to evaluate the influence of all possible factors. Much of the research has been done at the instigation of the Joint ASCE-ACI Committee on Shear and Diagonal Tension under sponsorship of the Reinforced Concrete Research Council. One of the studies conducted at the University of Illinois is the basis for a paper, to be presented at the joint session, entitled "Effect of Axial Compression on Shear Strength of Reinforced Concrete" by J. W. Baldwin, Jr., instructor in theoretical and applied mechanics at the University of Illinois, and Ivan M. Viest, bridge research engineer for the AASHO Road Test. The investigation included specimens that permitted variation of the ratio of axial force to shear systematically from zero to six, covering the full range from pure bending (no axial force) to a compression member failure. Through these studies

and others, the phenomenon of shear is being revealed so that adequate provision can be made for it under all possible conditions.

Continuing the discussion of shear, Charles S. Whitney, partner in Ammann and Whitney, will present a paper on "Ultimate Shear Strength of Reinforced Concrete Members Without Shear Reinforcement." The method of estimating shear strength proposed in this paper is radically different from that currently in use. The author bases his proposed method on results of tests covering a wide range of physical proportions and concrete and steel strengths. Considerable discussion of this paper is anticipated.

Perhaps one of the most significant current developments in reinforced concrete concerns the use of deformed reinforcing bars of high strength steels having yield strengths of 70,000 psi and more. The Portland Cement Association, in the construction of its new Structural Laboratory and Fire Research Center at Skokie, Ill., decided to use precast concrete construction throughout. The 58-ft-span roof girders depart from conventional practice by the very slender cross section, the high-strength, longitudinal tension reinforcement, and inclined stirrups not welded or otherwise rigidly attached to the longitudinal steel. Furthermore, the girders were designed by ultimate strength procedures given in the Appendix to the 1956 ACI Building Code with some departures justified by model girder test results. J. R. Gaston, associate development engineer, and Eivind Hognestad, manager of the Structural Development Section of the Portland Cement Association, will present a paper on "Development of Precast Concrete Girders Reinforced with High Strength Deformed Bars." This paper will show that it is entirely safe and satisfactory in the instance described to depart in several respects from the Code provisions.

Daniel W. Mead Prizes to Be Presented

Award of the Daniel W. Mead Prizes for 1957 was announced by the Board of Direction at the Annual Convention in October, and the winners were listed in the November issue (page 85). The Junior Member winner, Robert Braden, of Houston, Tex., will receive his award at the forthcoming Chicago Convention. Presentation of the student award to R. D. Frowein, of San Francisco, Calif., will take place later at some convenient Society function.

Mr. Braden, the Junior Member winner, will receive $100 in cash and a certificate. A native of Amarillo, Tex., Mr. Braden has lived in Houston since his graduation from college in 1954. He has a bachelor of science degree in civil engineering from the University of Texas, where he graduated in 1953, and a master of science degree in civil engineering from Massachusetts Institute of Technology, which he earned in 1954. Since completing his graduate work, which was in the field of hydraulics, he has been employed by the Houston consulting firm of Freese, Nichols & Turner. He is a member of the Houston Branch of the Texas Section.

Mr. Frowein, whose prize will consist of $50 in cash and a certificate, is junior engineer in the Schedules & Records Department in the Kaiser Engineers Division of Henry J. Kaiser Company. He attended the University of California at Berkeley, while working part time for Kaiser Engineers. Since his graduation last June, with a B.S. degree in civil engineering, he has been with Kaiser Engineers on a full-time basis. He is responsible for scheduling and writing progress reports and final reports on work at Eagle Mountain Mine, for the Fontana Precipitator Program, and for portions of the expansion program at the Fontana Steel Plant.

In the Mead Contest, both young men wrote on the subject, "Under What Conditions Should Faculty Members Engage in Outside Professional Engineering Practice?"

Robert Braden

R. D. Frowein

Arthur James Dyer, Hon. M. ASCE, Dies

Arthur James Dyer, Honorary Member of ASCE and former Society officer, died in Nashville, Tenn., on December 23. He was 90. Founder of the Nashville Bridge Company and for the past seventeen years chairman of its board, Mr. Dyer also had a wide range of civic interests and responsibilities. He was particularly noted for his local planning and development work, and for his untiring services to his alma mater, Vanderbilt University.

A transplanted Southerner, Mr. Dyer was born in Massachusetts and taken to Nashville as a child. He was connected with several steel companies before forming the Nashville Bridge Company, which he served as president from 1902 to 1940. Under his direction the company built many prominent bridges throughout the South and in Mexico. Mr. Dyer also pioneered in the organization of power developments in the Tennessee Valley. As chairman of the Nashville Planning Commission for twenty-three years, he was responsible for many community development and betterment projects. He was the major benefactor of the Vanderbilt University observatory and the mechanical engineering building and laboratory.

Mr. Dyer joined ASCE as an Associate Member in 1901, becoming a member two years later. He served as Director from 1922 to 1924, and as Vice-President in 1929 and 1930. In 1944 the Society conferred honorary membership on him in recognition of his "sustained interest in the Society and the profession." Mr. Dyer was also one of the founders of the American Institute of Steel Construction, which he served in many capacities.

E. R. Needles Takes Office as EJC President

"The United States is challenged now as a world power because of misdirection of its technological program, not because of the lack of present technological capability." Enoch R. Needles, Past-President of ASCE and a prominent New York City consulting engineer, made this statement at his installation, on January 10, as president of Engineers Joint Council, the unity organization of the engineering profession. When he took office at the Board of Directors meeting, Mr. Needles summed up the present situation as it relates to engineering and science.

"The situation in which we find ourselves," said Mr. Needles, "is not the result of technological failure. It is rather the result of mistaken decisions in program emphasis and manpower administration during the past decade. To ascribe the Russian rocket and satellite lead to weakness in American technology is misleading and erroneous. There is no evidence to indicate that the 'race' is temporarily lost for technological reasons.

"There is no question but that any one of several engineering and scientific organizations could have won the 'race' to get an earth satellite into the air if this had been considered of prime political significance, and if this was to have been used as the basic measure of our technological excellence. We have not lost our technological leadership or engineering productivity, but we must push everlastingly forward in our educational processes for engineers and scientists and the orderly and intelligent administration of their endeavors and services."

Supplementing these thoughts, Mr. Needles emphasized that "educational reform can have absolutely no effect on our technological performance during the crucial next three years when our technical accomplishments must be truly in keeping with our great capabilities, to restore the temporarily dimmed prestige of the U.S. The first step the country must take is to provide adequate administration and direction for the technological team of scientists and engineers which exists."

Mr. Needles also stressed the need for caution in long-range fundamental educational programs. "Educational reemphasis," he concluded, "which can have only long-range effects should be concerned primarily with the quality of that education rather than the quantity."

Mr. Needles reminded the group that as far back as January 1955 Engineers Joint Council, together with the Columbia School of Engineering, warned the nation of the new perilous position of this country in a press conference entitled "The Cold War for Engineering Manpower," in which, for the first time, the United States lag in manpower and misuse of its technological team was made clear to the American public.

E. R. NEEDLES
President of EJC

"The role of Engineers Joint Council, the organization through which the engineering profession can make itself heard," concluded Mr. Needles, "is more vital than ever. And in this instance it is saying most emphatically that the technical force of the United States is capable of meeting any challenge to world supremacy, providing it is given the responsibility and administration it needs."

In the presidency of EJC, Mr. Needles succeeds Joseph W. Barker, M. ASCE. O.B.J. Fraser, assistant manager of the Development and Research Division of the International Nickel Company, has been installed as vice-president.

EJC is a federation of 17 major national and regional engineering societies representing more than 250,000 of the nation's engineers.

ASCE Honorary Member Frank A. Banks Dies

Frank A. Banks, who was known all over the world as a builder of great dams, died in Pasadena, Calif., on December 14. He was 74. A member of ASCE since 1915, when he became an Associate Member, Mr. Banks was elected Honorary Member in 1955 in recognition of his service to the nation, especially in the development of the Columbia Basin.

A native of Maine and a graduate of the University of Maine, Mr. Banks went West in 1906 to grow up with the recently established U.S. Reclamation Service (now the Bureau of Reclamation). In the Bureau he rose from such jobs as costkeeper and rodman to become construction engineer and district manager in full charge of construction and development of the great Columbia Basin Project. His work in the latter capacity culminated in the construction of Grand Coulee Dam and power plants. As construction and supervising engineer and project manager for the Bureau from 1933 to 1950, Mr. Banks was in charge of the construction of four large earth dams and all irrigation facilities built during the period in addition to Grand Coulee Dam. After voluntarily retiring from the administrative responsibilities of the project in 1950, he continued to serve the Bureau as consultant.

After his retirement Mr. Banks also was consulting engineer to the Province of British Columbia on the construction of Kenny Dam and to the Government of India on the construction of Bhakra Dam. He was also active in many agencies concerned with better development and utilization of the Columbia Basin resources. Mr. Banks' many honors included the Distinguished Service Award, highest honor of the U.S. Department of the Interior. The citation said, in part, that his work "across the valley of the Columbia will aid the nation as long as water runs downhill."

At the time of his death Mr. Banks was federal representative and chairman of the Columbia Interstate Compact Commission and the Federal-Compact Commission for the Klamath River Basin; chairman of the Water Management Subcommittee of the Columbia Basin Interagency Committee; and member of many international committees.

Division Doings

Air Transport Division Reports On Heliport Standards

The Air Transport Division's Air Center Committee (formerly the Heliport Committee) has been assembling publications dealing with the establishment of heliports, with the idea of making a bibliography for the convenience of engineers who are designing and building such facilities. The committee has developed the term "Air Center" in preference to "Heliport" in the belief that it more aptly describes a facility designed to serve other types of steep gradient aircraft in addition to helicopters. "Air Center" is defined as an "area for the operation of rotary wing, STOL, and VTOL aircraft having vertical or short landing and take-off characteristics."

Publications dealing with standards for heliport construction, known to the Air Center Committee, are:

1. National Requirements for Aviation Facilities, 1956-1975. Vol. III—Aircraft Characteristics, Part 1, Civil Aviation.
2. Minutes of Second Helicopter Meeting, Brussels, International Air Transport Association, February 1955.
3. Heliport Location and Design—The Port of New York Authority, May 1955.
4. Minutes of Third Heliport Meeting, San Remo, International Air Transport Association, May 1956.
5. A Study of Heliports for Baltimore City, by Thomas F. Hubbard and John J. Lang, January 1954.
6. Transport Helicopter Design as Related to Operating Cost and Heliport Requirements, by David Schnebly, August 1955.
7. Heliports for Houston, City Planning Commission, Houston, Tex., April 1954.
8. Helicopter Landing Areas, Sikorsky Aircraft, August 1, 1953.
9. Discussion of Helicopter Landing Areas—Piasecki Helicopter Corporation, November 1953.
10. Heliports in the City Plan—American Society of Planning Officials, July 1953.
11. Planning for Urban Heliports, by Robert Horonjeff and Howard S. Lapin—The Institute of Transportation and Traffic Engineering, University of California, June 1954.
12. The Planning of Air Stations for Single Engine Helicopters—Ministry of Transport and Civil Aviation, London, England, 1956.

Structural Division Committee on Electronic Computation

Nathan M. Newmark, head of the civil engineering department at the University of Illinois, heads the Structural Division's new Committee on Electronic Computation, and Stephen J. Fenves, an instructor there, is secretary.

At a recent meeting in Chicago the committee laid the groundwork for its future program by establishing task committees in the following fields of application of digital computers to structural engineering:

1. Programming and coding of structural problems, development of standard terminology, and exchange of information.

2. Review and development of mathematical methods best suited to high-speed computation.

3. Investigation and development of statistical applications, such as reduction of field performance, cost, and test data.

4. Presentation and publication of technical papers.

5. Establishment of a Program Directory and a central library on computer applications.

The committee has scheduled a session on computers at the Chicago Convention (page 79) and will sponsor a symposium on structural applications next fall.

SOCIETY AWARDS AND FELLOWSHIPS AVAILABLE

DANIEL W. MEAD PRIZES:	*1958 contest closes May, 1958. See 1957 Official Register, page 132; January 1958 issue of CIVIL ENGINEERING, page 77.*
FREEMAN FELLOWSHIP:	*1958-1959 award closes May 1, 1958. See Official Register, page 142.*
J. WALDO SMITH HYDRAULIC FELLOWSHIP:	*1958-1959 award closes May 1, 1958. See Official Register, page 143; January 1958 issue of CIVIL ENGINEERING, page 77.*

Joint Manual on Sewers

As noted in the January issue (page 77), a committee of the Society's Sanitary Engineering Division has been working for several years with the Federation of Sewage and Industrial Wastes Associations in the preparation of a Manual on the Design and Construction of Sanitary and Storm Sewers. Members with a professional interest in maintaining the high standards set for ASCE Manuals are invited to review and comment on the proposed Manual. A very limited supply of the manuscript is available on a loan basis.

The Board of Direction will appreciate any such critical comment before its final clearance of the project. Copies may be borrowed for a period of up to two weeks. Comments may be mailed to the Committee on Preparation of a Manual of Practice on Sanitary and Storm Sewer Design and Construction at ASCE headquarters until March 15.

ASCE Membership as of January 9, 1958

Members	9,807
Associate Members	13,305
Junior Members	17,125
Affiliates	77
Honorary Members	44
Total	40,358
(Jan. 9, 1957	39,161)

ASCE QUARTERLY ENGINEERING SALARY INDEX

Consulting Firms

City	Current	Last Quarter
Atlanta	1.11	1.11
Baltimore	1.11	1.10
Boston	1.13	1.13
Chicago	1.26	1.12
Denver	1.19	1.14
Houston	1.08	1.08
Kansas City	1.14	1.11
Los Angeles	1.16	1.16
New York	1.17	1.17
Pittsburgh	0.93	0.91
Portland	1.15	1.15
San Francisco	1.18	1.21
Seattle	1.07	1.07

Highway Departments

Region	Current	Last Quarter
I, New England	0.88	0.88
II, Mid. Atlantic	1.15	1.12
III, Mid. West	1.24	1.19
IV, South	1.02	1.05
V, West	0.96	0.96
VI, Far West	1.15	1.12

Figures are based on salaries in effect as of Nov. 15, 1957. Base figure, the sum of Federal Civil Service, G. S. Grades 5, 7, and 9 for 1956, is $15,930.

Maine Section Host to Large Highway Conference

Some 225 members, guests and students gathered at the University of Maine on December 13 for the annual two-day Highway Conference sponsored by the Maine Section in cooperation with the Maine State Highway Commission and the University of Maine Student Chapter. This year's theme, the Interstate Highway Program, was introduced by Weston S. Evans, Acting Dean of the College of Technology and Director of District 2. Three excellent student papers —by Charles B. Nicholl, Allen P. Tracy, and Albert L. Godfrey—set the pace of the conference. Lester J. Ellis, right-of-way engineer for the Massachusetts Department of Public Works, and R. W. Manzer, chief highway engineer of the Department of Public Works, Province of New Brunswick, each gave an interesting report on the work of their departments.

It was the consensus of the afternoon session that the availability of materials, equipment, and manpower would not pose a serious threat to construction of the Interstate System. Contributors to this view were Stanley H. MacArthur, vice-president of the Glen Falls Portland Cement Company; L. Abbet Post, executive vice-president of the American Institute of Steel Construction; A. R. Curtis, of Esso Standard Oil Company; Philip V. Cory, president of W. H. Hinman, Inc.; John Clarkson, president of Clarkson Engineering Company of Boston; and Louis W. Prentiss, executive vice-president of the American Road Builders Association. At the evening session, E. Beach Bly of the Vermont Department of Highways, Barnard Langley of the New Hampshire Department of Public Works and Highways, and David H. Stevens, chairman of the Maine State Highway Commission, reported on progress of the Interstate System in their states. Assistant Commissioner of the Maine Bureau of Public Roads, George M. Williams, discussed plans for financing the system. W. B. McKendrick, Jr., and A. E. Johnson, both connected with AASHO, reported their conclusions on road tests, and the educational preparation of engineers. The sessions were presided over by President Daggett, Charles F. Parker, Lucius D. Barrows, and Lawrence K. Murphy.

Prominent on the program of the annual Highway Conference sponsored by the Maine Section, the Maine State Highway Commission, and the University of Maine Student Chapter were (left to right) George M. Williams, E. Beach Bly, David Stevens, Lucius Barrows, and Bernard H. Langley.

Metropolitan Section's Junior Members Celebrate Silver Anniversary

The Junior Members of the Metropolitan Section didn't look back at the recent celebration of their 25th anniversary. Considerable emphasis was placed on what is ahead by the principal speaker, Dr. Mario Salvadori of Columbia University. In facing the future, the speaker stated that the technological revolution is just starting, and its impact on our culture is just beginning to be felt. "Above all," said Professor Salvadori, "the engineer must be elastic, he must be ready to accept change. He should reject the philosophy, 'I only know what I have been taught,' and be ready to abandon any knowledge we already have for new knowledge."

The speaker also emphasized the need for an ability to work with people in intellectual teams. "In today's world, the genius can no longer work alone." He also underscored the great need for an intimate knowledge of mathematics, as a basic tool of the engineer. While mathematics is a basic element of our culture and learning, he noted that presumably intelligent people who would not dare admit to ignorance of music or literature frequently consider it quite fashionable to profess their complete inability to understand mathematics.

Prior to the main talk of the evening, Prof. Milton Alpern of Cooper Union, this year's president of the Junior Member Forum, gave a short talk on the history of the organization, spotlighting his comments with slides of famous engineering works that have been built since its formation. It surprised many to see what has taken place in the past 25 years. President Alpern's remarks were supplemented by the recollections of many past-presidents who were in attendance.

Among those present were ASCE Executive Secretary W. H. Wisely; Edwin S. Burdell, president of Cooper Union; ASCE Vice-President Waldo Bowman; Section president Roger Gilman, and many past officers of the Society.

At silver anniversary celebration of the Metropolitan Section's Junior Forum are (left to right) Mrs. Milton Alpern; Forum President Alpern; Robert Roy, and speaker of the evening Mario Salvadori.

NOTES FROM THE LOCAL SECTIONS

(Copy for these columns must be received by the fifth of the month preceding date of publication)

Key figures at Alabama Section's winter meeting are (left to right) Kenneth C. Roberts, immediate past-president; Don Mattern, ASCE Director for District 10; and Richard S. Woodruff, program committee chairman. Industrial locations and water derived from the Warrior-Tombigbee River System were the theme of the meeting. Speakers were Jack W. Warner, president of Gulf States Paper Corporation and the Warrior-Tombigbee Development Association, and Kenneth Byrd, vice-president of J. W. Goodwin Engineering Company. Slated to head the Section in 1958 are Warner G. Keith, president; John C. Clarke, first vice-president; Rudolph Landberg, second vice-president; and L. A. Woodman, secretary-treasurer.

With thanks to **Central Illinois Section** members for their active support during 1957, President Junius Gardner turned the Section's December meeting over to president-elect Ellis Danner. Slated for the Section's top positions in 1958 are Paul L. Zumwalt, first vice-president; Clyde E. Kesler, second vice-president; and William J. Hall, secretary-treasurer. Four members of the University of Illinois' Department of Civil Engineering presented a report on the Fourth International Conference on Soil Mechanics and Foundation Engineering, held in London recently. Messrs. R. B. Peck, D. U. Deere, H. O. Ireland, and R. K. Morse also discussed their trips through parts of Europe and Asia.

Newly installed officers for the **Central Ohio Section's** 1958 season are Roy T. Underwood, president; O. H. Jeffers, first vice-president; Robert F. Baker, second vice-president; and S. W. Dudley, secretary-treasurer.

Prelude to the December meeting of the **Connecticut Section** was a tour of the Yale University campus, conducted by Student Chapter hosts. Prof. Ed Gant reported on the recent meeting of the New England Council, and James D. Parsons, of Moran, Proctor, Mueser and Rutledge, of New York, topped the program with an informative talk on "Foundation Aspects of Varved Glacial Lake Deposits." Slated for office in the coming year are William G. Weaver, Jr., president; Henry A. Lepper, Jr., vice-president; and Frank J. Zameenik, secretary-treasurer.

The Architects and Engineers Institute in Atlanta, Ga., was a busy place on December 7, when the **Georgia Section** convened for its forty-fifth annual meeting. Featured speaker at the annual luncheon was ASCE President Louis R. Howson, who discussed the Society's plans for the coming year and the progress made toward construction of the United Engineering Center in New York City. The red-letter day ended with a gay dinner-dance at the Fort McPherson Officers' Club. New Section officers are Carl E. Kindsvater, president; Ray A. Nixon, resident vice-president; Robert M. Young, vice-president at large; and John E. Bing, secretary-treasurer. The **Central Savannah River Valley Branch** had an interesting meeting when A. M. Mooney, assistant district manager of the Raymond Concrete Pile Company, presented a sound movie showing the construction of the Lake Pontchartrain Causeway in Louisiana. Branch president for the 1958 season is Murray A. Ruth. He will be assisted by J. M. Gibson, vice-president, and C. W. J. Smith, Jr., secretary-treasurer, who remains in office. "The $40,000,000 Expansion Program at Union Bag-Camp Paper Corporation" was discussed by Dr. H. Y. Charbonnier at the **Savannah Branch's** December 11 meeting. Following the interesting talk, new Branch officers were announced. President is James Edgerton; vice-president is Juel K. Haugan; and James R. Marable is secretary-treasurer.

The **Hawaii Section** is busy with plans for a post-Portland Convention tour, June 29-July 7. Two days of scheduled events are planned for July 1 and 2, with technical sessions, field trips and an

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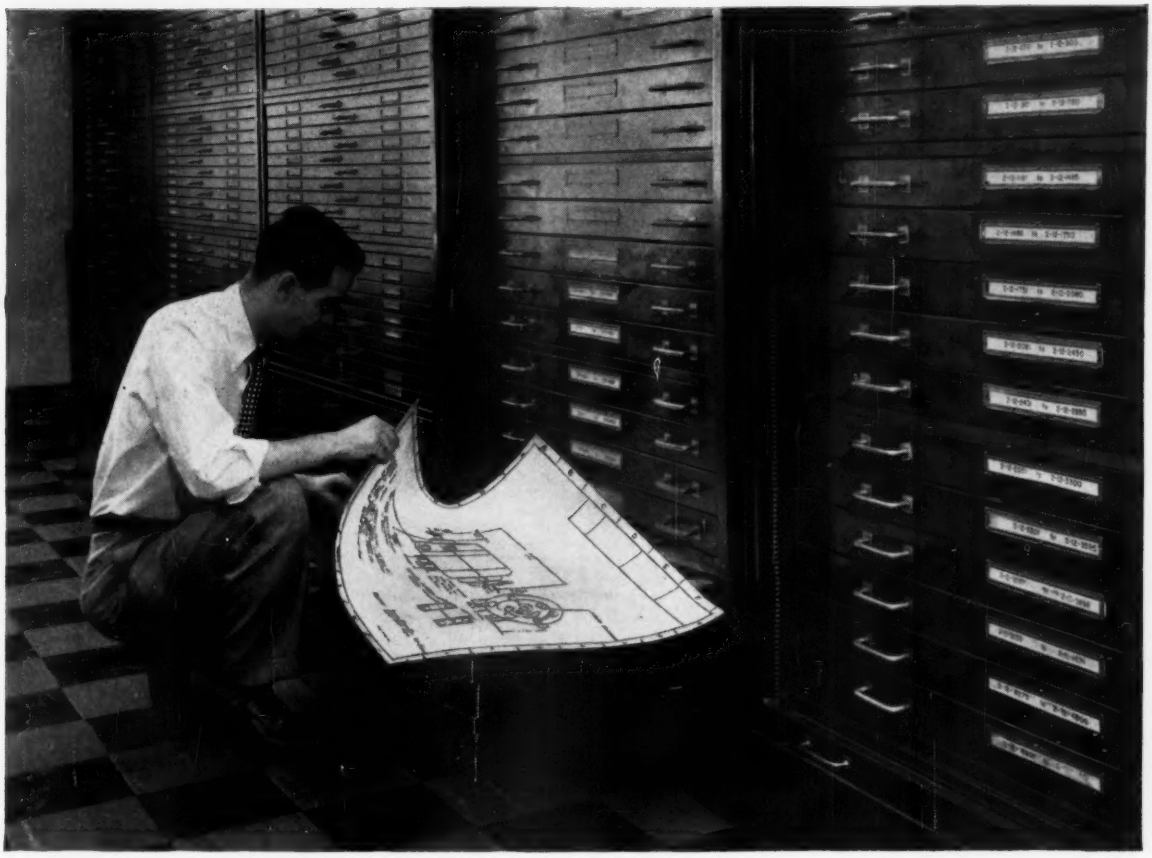
Colorado Section gavel is received by newly elected president Emerson S. Ellett from outgoing president Dewey S. Wright. Left to right are S. Mark Davidson, secretary-treasurer; Leo C. Novak, vice-president; and Messrs. Ellett and Wright.

ASCE prize-winners receive awards from Society Director Clarence L. Eckel (left in both photos) at Colorado Section dinner-dance. At left, William E. Wagner receives the J. James R. Croes Medal and at right Harold J. Gibbs, the Arthur M. Wellington Prize.



How filing a drawing can shorten its life

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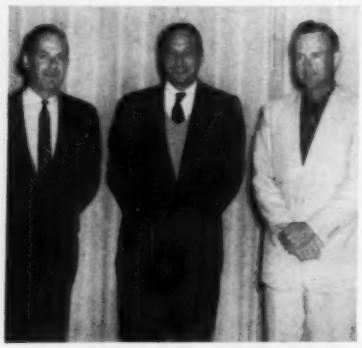
TRADE MARK

William G. Riddle (right) greets L. W. Bremser, his successor as president of the Kansas City Section. Mr. Bremser was elected at the Section's December 10 meeting.



All smiles are the Miami Section's new officers. In usual order are Herbert Saffir, vice-president; Murray Mantell, president; and Howard Post, secretary. Section treasurer, not shown here, is J. Buckley.

evening cocktail party and banquet. It seems an excellent opportunity to combine professional advancement with a wonderful vacation. All events will be held at Kaiser's Hawaiian Village Hotel, where rooms have been reserved in anticipation of visitors. Space has also been reserved on Northwest Airlines tourist flights of June 28 and 29 to bring persons attending the Portland Convention. Anyone desiring more information may write to Arthur Chiu, Hawaii Section ASCE, P.O. Box 917, Honolulu 8, Hawaii.

Election returns just in from the **Illinois Section** name John A. Logan president; Robert L. Kennedy, vice-president; Robert L. Hall, secretary, and John G. Hendrickson, Jr., treasurer.

Chief executives of the **Indiana Section** for 1958 are Joseph I. Perrey, president; James R. Cooper, vice-president; Gerald H. Teletzke, secretary-treasurer; and Malcolm D. Hale, assistant secretary-treasurer.

A timely and controversial subject absorbed **Lehigh Valley Section** members at their December meeting, when Dr. Aurie N. Dunlap, assistant professor of international relations at Lehigh University, spoke on "Sputnik Diplomacy and the NATO Conference." New Life Members honored were Harold O. Hill, John B. Smiley, and William H. Wilson. Officers for the coming season are Robert De Moyer, president; John M. Adams, first vice-president; and Edward M. Cummings, second vice-president. President De Moyer presented a certificate of appreciation to outgoing president Rollin B. Foster. ASCE Director E. L. Durkee discussed the possibility of forming a Central Pennsylvania Section.

Indiana Section paid special tribute to ASCE Honorary Members Howard S. Morse (left) and Ralph B. Wiley (right), at recent dinner meeting. Here Daniel Terrell, Past-President of the Society, congratulates the two.

What is professional growth? The **Los Angeles Section's** Committee on Engineering Education has sent out over 1,000 questionnaires to Junior Members within the Section, in order to discover the attitudes of young engineers toward this important question. Results of the professional growth survey should prove both interesting and helpful.

At the helm of the **Louisiana Section's Shreveport Branch** for 1958 are V. A. Lyons, president; Chris Demopolus, first vice-president; J. C. McLemore, second vice-president; J. L. Davis, III, secretary; and T. B. Shelfer, treasurer.

The full agenda of the **Maryland Section's** December meeting was highlighted by announcement of new officers. They are Albert L. Grubb, president; Bernard L. Werner, vice-president; and James W. Davis, secretary-treasurer. Speaker of the evening, Alfred Hedefine, partner in the New York firm of Parsons, Brinckerhoff, Hall & Macdonald discussed the design of the channel crossing for the Baltimore & Ohio Railroad's new bridge over the Arthur Kill between Staten Island and New Jersey. When completed it will be the world's longest vertical lift span.

A very special social meeting was held recently by the **Mexico Section,** when members and their wives gathered to celebrate Lorenzo Perez Castro's recent election as an Honorary Member of ASCE.

Michigan Section officers for 1958 are Elihu Geer, president; Leonard L. Klein, first vice-president; Carl Johnson, second vice-president; and Robert Zumpstein, secretary-treasurer.

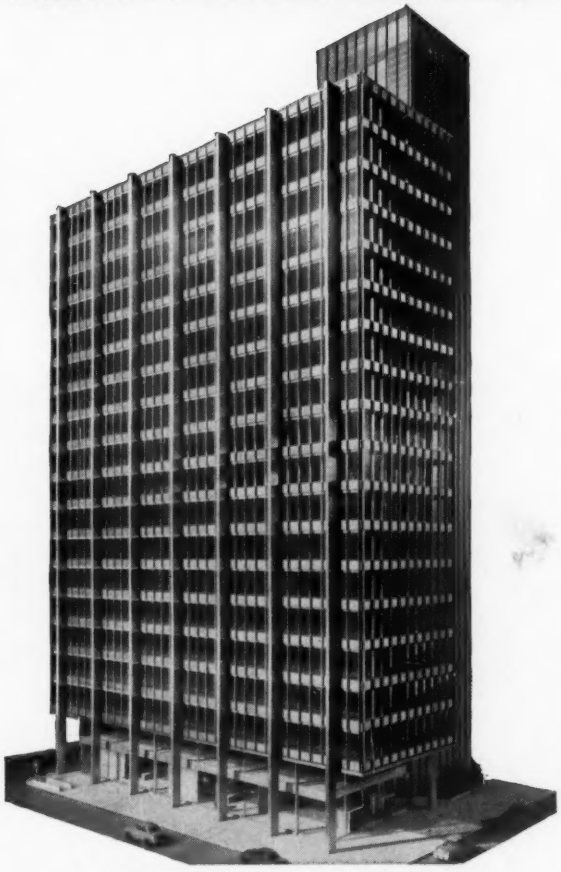
The balloting is over in the **Mid-South Section's Little Rock** and **Jackson Branches.** Little Rock Branch officers are W. B. Dickinson, Jr., president; John W. Courter, vice-president; and Joe L. McKinstry, secretary-treasurer. Officials of the Jackson Branch are James E. Foster, president; James M. Polatty, vice-president; and James D. Shell, secretary-treasurer.

The **Mohawk-Hudson Section** announces that its 1958 officers are Holbert W. Fear, president; Cliff S. Barton, first vice-president; Haaren A. Miklofsky, second vice-president; Thomas J. Buchanan, secretary; and Erhard E. Dittbrenner, treasurer.

Modern trends in city planning and their relationship to civil engineering, were considered at a recent **Nebraska Section** meeting by Eldridge Lovelace,

Weldynamics

ARC WELDING AT WORK CUTTING COSTS

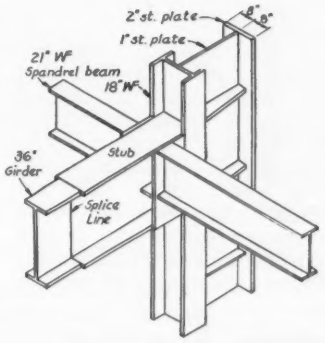


Weldynamics paves the way for new and better design

Creative ingenuity, made practical by Weldynamics, came forth with this 19 story building with a column free interior. All floors are suspended between 14 exterior columns. Thus the architect was able to provide more floor space free from obstruction.

The exterior columns are shop fabricated with automatic Lincolnweld submerged arc welding. Down-hand field welding is accomplished with Lincoln Jetweld LH-70, iron powder low-hydrogen electrodes for welding speed and economy.

The Inland Steel Company Building, Chicago, Illinois. Erected by John B. Beasley Construction Company; shop fabrication by Joseph T. Ryerson & Son, Inc.; General Contractor, Turner Construction Company; Architects, Skidmore, Owings and Merrill.



Typical column to which a stub support, part of a torque box, is welded.

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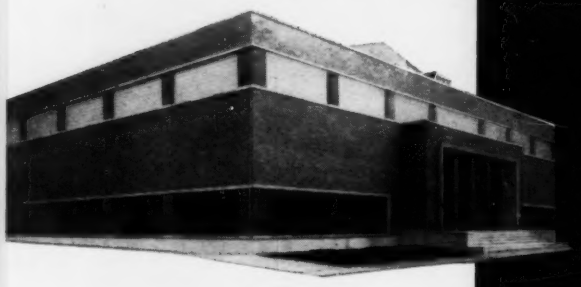
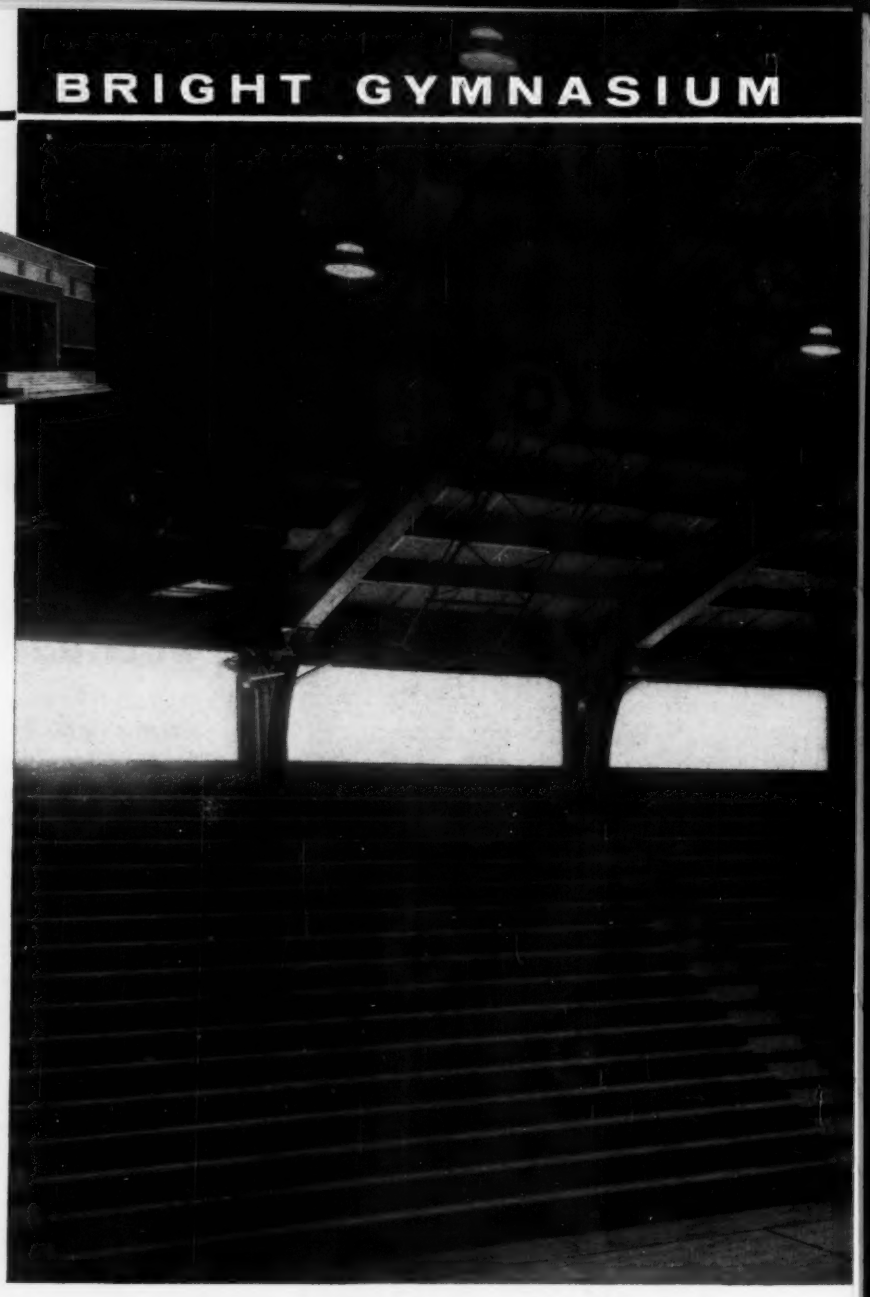
A BIG, BRIGHT GYMNASIUM





BLUFFTON HIGH SCHOOL GYMNASIUM

Architect: A. M. Strauss, Incorporated, Fort Wayne, Ind.

General Contractor: W. A. Sheets & Sons, Fort Wayne, Ind.

Structural Steel Fabricator: Art Iron & Wire Works, Inc., Toledo, Ohio.

Clear-span construction with USS STRUCTURAL STEEL keeps costs down

The vast, postless interior of Bluffton High School Gymnasium at Bluffton, Indiana, gives every spectator a clear, unobstructed view of the playing area. The rigid frame steel construction offers strength, safety, economy of erection, and minimum maintenance—four considerations which are mandatory in present-day school building. Notice the ample amount of window area made possible by rigid frame construction.

WHY IT PAYS TO USE STRUCTURAL STEEL

No other common structural material is as *strong* as steel, as *practical* as steel, as *safe* as steel. But architects and engineers need no convincing. They specify structural steel every day for more and more schools, churches, and similar medium-sized structures—as well as for huge skyscrapers, bridges, and aircraft hangars. The versatility of structural steel is not limited by the size of the building. Look at some of these specific advantages of structural steel:

- It is the *strongest*, yet *most economical* of load-bearing materials.
- Structural steel will withstand more abuse than other structural materials, effectively resisting tension, torsion, compression and shear.
- Once enclosed in buildings, it requires no maintenance—lasts indefinitely.
- Structural steel may be riveted, bolted or welded . . . can be erected in any weather.
- Steel members are fabricated indoors, where weather can have no effect on the quality of the workmanship.

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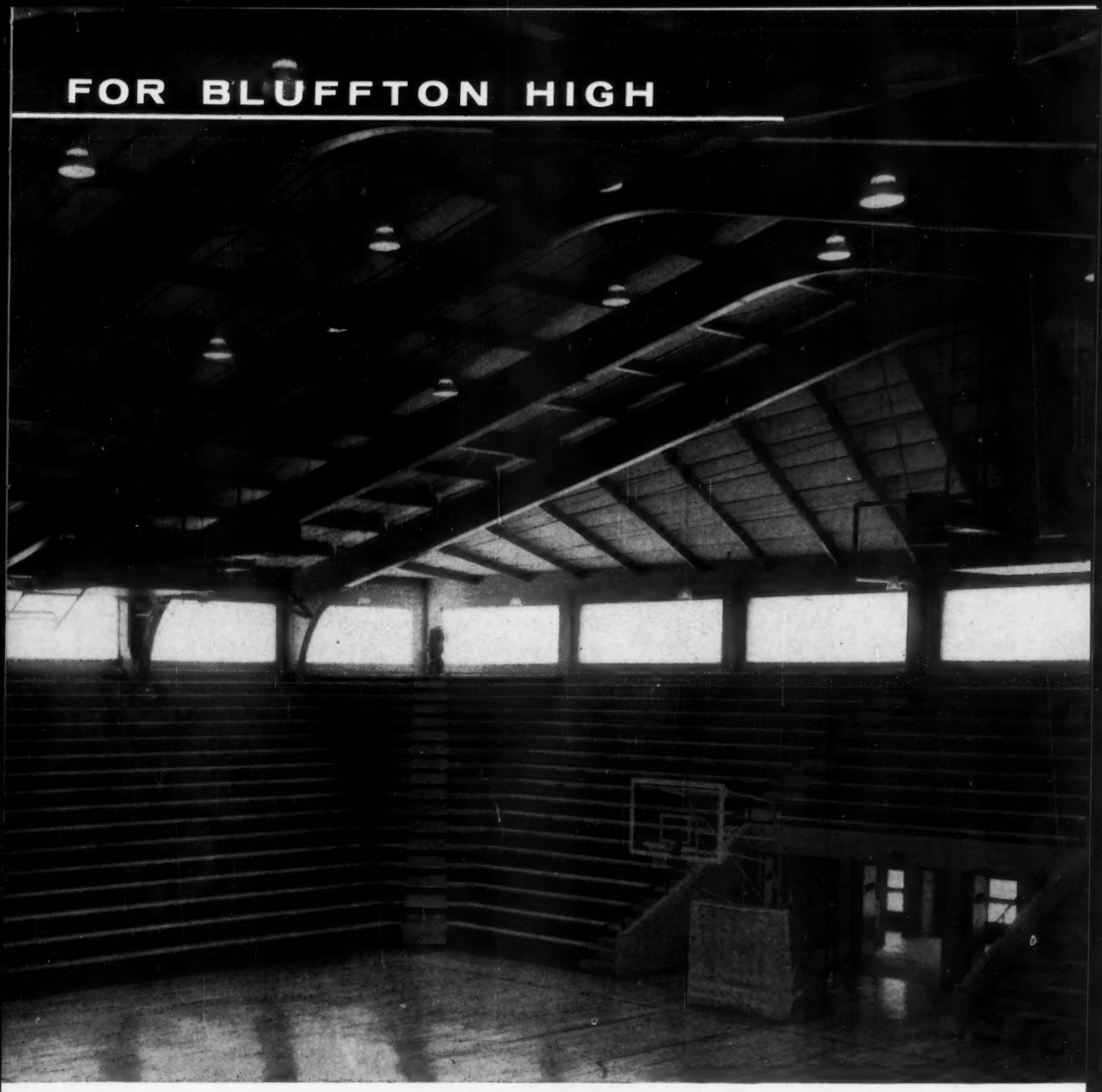
Columbia-Geneva Steel Division, San Francisco
Tennessee Coal & Iron Division, Fairfield, Ala.
United States Steel Supply Division, Warehouse Distributors
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS STRUCTURAL STEEL

UNITED STATES STEEL

FOR BLUFFTON HIGH



Approximately 240 tons of USS Structural Steel were used in the construction of the gymnasium. The steel framework was erected in seven weeks—joining accomplished by bolting and welding. The total structure—masonry, floor, seats, fixtures, everything—was completed and ready for use in 12 months.

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Pittsburgh 30, Pennsylvania

Please send me a free copy of **Hot Rolled Carbon Steel Shapes and Plates**—a handbook containing details, dimensions and weights of all USS Structural Steel.

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Company ..... **Title** .....

Address .....

City ..... **State** .....

partner in the firm of Harland Bartholomew and Associates. The pertinent talk was well received by members.

Reports from the **Northwestern Section** indicate that it is all set for the coming year. New officers are Charles H. Prior, president; John E. Meyer, first vice-president; James A. Lindsey Jr., second vice-president; and Norman E. Henning, secretary-treasurer. At the helm of the Section's **South Dakota Branch** are George Jacobson, president; Jack Blaess, first vice-president; George Cawelti, second vice-president; and Emory Johnson, secretary-treasurer.

Slated to preside over the **Oklahoma Section's Oklahoma City Branch** for the coming year are Guy N. Keith, chairman; Edward J. Glendening, vice-chairman; and Virgil W. Smith, Jr., secretary-treasurer.

The possibilities of seismic investigation for sub-surface exploration were considered at a recent **Oregon Section** meeting, at which Boyd Bush, of GEO-RECON, Oregon, Ltd., was featured speaker. Seismic exploration, he said, though faster, cheaper and more informative than borings, will not replace them for core sampling and analysis. On large jobs, however, exploration can decrease the number of drillings necessary.

"Something old, something new" is the motto of the **Philadelphia Section** this month, which has resumed publication of "The News," and activated its recently organized Hydraulic and Sanitary Engineering Division. With its first official meeting this fall, the new division assumed permanent status. Its officers are Elwood L. Bean, chairman; Romeo A. Falciani, vice-chairman; and Walton Purdom, secretary.

The **Pittsburgh Section's Junior Member Forum** has just reported its new officers. President for the coming year is Dr. James P. Romualdi; Sherwood Richardson is secretary.

Can the consulting engineer ignore the unionization question? Is ASCE active in this field? These and other questions affecting the profession have been under study by the **Junior Member Forum** of the **San Francisco Section,** which has prepared a four-page report on its findings. The Section now has its own permanent office, located in Room 302 of the Atlas Building at 604 Mission Street.

ASCE Past-President William Roy Glidden was honored at a recent meeting of the **Virginia Section** for his "unselfish devotion and distinction" in service to the Society and the Section. The resolution acknowledging Mr. Glidden's contributions commended him for his work as Virginia Section president, as well as for his long service to the Society. Mr. Glidden became a life member in January 1957. New **Richmond Branch** officers are Alfred W. Maner, president; Kenneth C. Saunders, vice-president; and Raymond S. Gordon, secretary-treasurer.

At the helm of the **Tennessee Valley Section** for the coming year are Nathan E. Way, president, and Hendon R. Johnston, vice-president.

At a recent meeting, members of the **Texas Section's Austin Branch** heard an interesting talk on locating offshore leases in the Gulf of Mexico. Speaker of the evening was Curtis R. Hale, engineer with the General Land Office. San Antonio's hospital needs were the topic of an interesting talk given by William Hamrick, administrator of the proposed Methodist Hospital, at the December meeting of the **San Antonio Branch.**

Typical of successful get-togethers staged by the Rhode Island Section was this recent meeting with the Providence Engineering Society. Here the joint group enjoys a second common interest.

ASCE CONVENTIONS

CHICAGO CONVENTION
Chicago, Ill.
Sherman Hotel
February 24-28, 1958

PORTLAND CONVENTION
Portland, Ore.
Multnomah Hotel
June 23-27, 1958

ANNUAL CONVENTION
New York, N. Y.
Hotel Statler
October 13-17, 1958

DISTRICT COUNCIL MEETINGS

DISTRICT 9 COUNCIL CONFERENCE
Akron, Ohio
Sheraton-Mayflower
April 18-19, 1958

DISTRICT 10 COUNCIL CONFERENCE
Atlanta, Ga.
April 11-12, 1958

PACIFIC SOUTHWEST COUNCIL CONFERENCE
Phoenix, Ariz.
Westward Ho
April 17-19, 1958

LOCAL SECTION MEETINGS

Cleveland—Dinner meeting at the Cleveland Engineering Society, February 21, 6:30 p.m.

Illinois—Weekly luncheon meetings at the Chicago Engineers' Club every Friday at 12 noon.

Joint Area Committee—Meeting at the University of Toronto, School of Nursing, Room 103, March 6, 6:30 p.m.

Lehigh Valley—Joint meeting with the Lehigh University Student Chapter, February 17. Information from A. J. Oudheusden, Jr., 1972 Hopewell Rd., Bethlehem, Pa.

Metropolitan—Meeting at the Engineering Societies Building, February 19, 7 p.m. Annual dinner meeting at the Brass Rail Restaurant, 100 Park Avenue, March 19, 6:00 p.m.

Northwestern—Sixth Annual Soil Conference in conjunction with the University of Minnesota at the University of Minnesota, April 3.

Philadelphia—Dinner meeting at the Engineers' Club, March 11, 6:00 p.m.

Tennessee Valley—Chattanooga Branch dinner meeting at the Hotel Patten, Chattanooga, March 11, 5:30 p.m.

Texas—Austin Branch dinner meeting at the Engineer & Associates Club, February 20, 6:30 p.m.

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BY-LINE WASHINGTON . . . . .

It will cost a staggering 37 percent more to construct the National System of Interstate and Defense Highways than anticipated, the Bureau of Public Roads told Congress here last month. Basing its new estimate on a thorough review of engineering, right-of-way, and construction costs submitted by the state highway departments, the federal highway officials announced that the big 41,000-mile roadbuilding effort will come to $37.6 billion. This is an increase of $10 billion.

The Bureau blamed unforeseen traffic increases, spiralling construction costs, and stiffer geometric design standards for the big jump in the estimate. Now, experts believe, traffic in 1975, the year for which the new roads are being designed, will be 15 percent higher than estimated back in 1955, necessitating a 5 percent increase in the highway plant. Construction costs are up 12 percent, and miscellaneous items, such as utility adjustments, lighting and signing, account for another 3 percent of the increase.

Largest portion, however, comes from acceptance of highway design requirements. The expressway standards adopted by state and federal officials a few months ago call for more consideration to serving local traffic and necessitate construction of 63 percent more highway grade separations, other structures, interchanges and frontage roads than had been figured into the 1955 estimate. This work calls for an estimated 15 percent increase in the total cost of the construction job.

* * *

Secretary of Commerce Weeks, testifying before the Gore Senate Subcommittee on Roads, opposed a number of proposals to amend the National Highway Program. Among other things, he urged:

- That no increase be made in the authorized mileage of the Interstate System, "until we can determine with reasonable certainty the revenues which will accrue to the Highway Trust Fund, the expenditures required to complete the System, and the need for adding to it."
- That federal funds should not be used to reimburse utilities for the cost of relocating their facilities in the rights-of-way of highways being modernized or rerouted. The Secretary pointed out that this loop-hole in the 1956 Act encouraged 16 state legislatures to pass laws this past summer approving the reimbursement of utilities for such costs. This "drastic" change in existing practices was not contemplated, he said, and federal funds used for this purpose obviously will not be available for construction.
- That Congress pass a law requiring that, in determining bridge clearances across navigable waters, the effect upon the cost of the bridge be considered, as well as the effect upon the interests of navigation. Millions of dollars can be saved in bridge costs every year, he declared, without unduly affecting water transportation, if the bridge clearances established with only navigation in mind are modified by considering the additional cost of construction.

* * *

Mr. Weeks' position that the highway program is proceeding satisfactorily was challenged, as expected, by Chairman Albert Gore. "There is a disturbing lack of uniformity" in progress from state to state in getting the big engineering job under way, the senator insisted. "How then can you report that the program is on schedule?"

Actually, only eight states are still behind in putting the federal funds to work, Federal Highway Administrator Bertram Tallamy reassured the committee and said they are fast catching up.

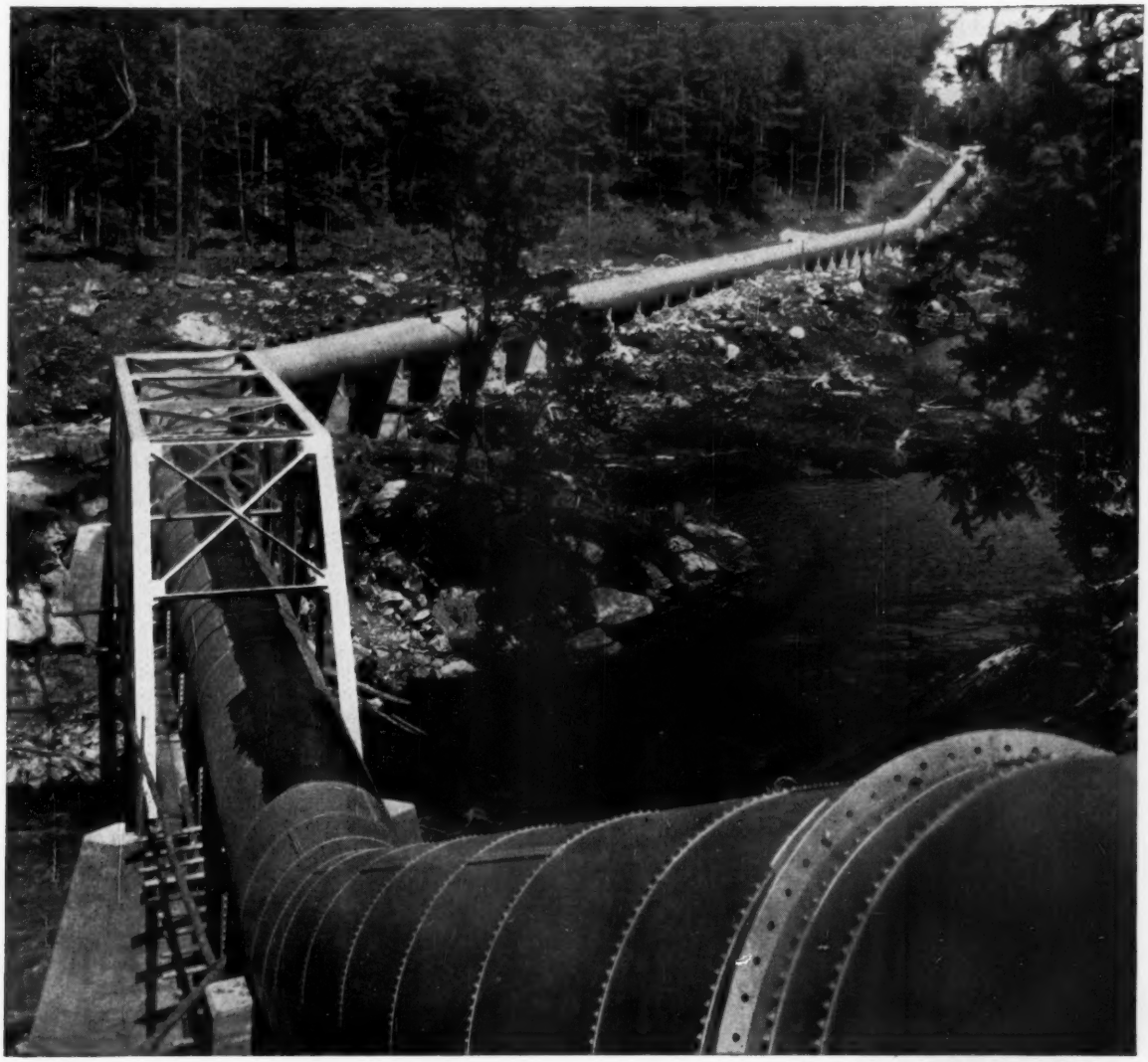
The committee also pointedly questioned the Bureau of Public Roads about the reliability of the new Interstate System cost estimate. Senator Gore remembered that the 1956 estimate was submitted without modification by the Bureau and that estimated construction costs in even adjoining states were significantly different. He cited Pennsylvania, which had turned in an estimate of $700 million to complete its portion of the network in 1956, compared with New Jersey's estimated $1,357 million. (The new estimate shows the Pennsylvania estimate boosted to $1,310 million and the New Jersey estimate lowered to $1,040 million.) "We'll stand back of this one," Bureau officials maintained.

* * *

The Administration proposed last month that Uncle Sam immediately launch a program of 40,000 college scholarships for students interested in engineering and scientific careers. The National Society of Professional Engineers struck back with the charge that this was entirely the wrong approach. Stirred into action by the Sputnik episode and the realization that the nation is not as scientifically strong as desirable, the Administration had tossed out its proposal to attract 10,000 young men a year into technical curriculums each year for four years.

Such a flood of students into engineering and science curriculums, however, would swamp institutions which are already struggling under inadequate finances and with skeleton teaching staffs, NSPE said. The emphasis should be on quality rather than quantity, and any such program should be accompanied by "substantial" assistance in boosting faculty salaries.

A host of other schemes are in the hopper, including one by House Republican Leader Joseph Martin who wants the federal government to sponsor scholarships for five top science students a year in each of the nation's 435 Congressional districts. And Senator Humphrey, in the meantime, says he will propose a new Cabinet-level Department of Science and Technology.



This photograph was taken in 1927.

No trouble in 30 years of constant service

Back in 1927 we furnished 10,235 ft of riveted steel pipe, with saddles, for this 7-ft-diameter penstock to serve Niagara Mohawk Power Corporation's Allen Falls, N. Y., hydroelectric station.

It was fabricated from $\frac{3}{8}$-in. to $\frac{9}{16}$-in. plates, with riveted girth joints on 10-ft centers. The pipe initially received only a shop coat and a field coat of red lead paint.

This pipe has been in constant service since 1927, operating with a head of 218 ft and a flow of 333 cfs, producing 4600 kw. During 30 years of continuous service there have been no pinholes, no leaks, nor any other damage to the pipe except for the minor loosening of some joints which were damaged when the wooden housing on the surge tank caught fire 20 years ago. These were simply caulked and have given no further trouble.

The pipe has been painted regularly and it looks just as good today as when it was first installed.

Reports like this, coming in from all over the country, indicate that steel pipe gives an extremely high quality of performance under the most demanding service conditions, for many, many years.

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NEWS BRIEFS . . .

Construction Activity Sets New Record in 1957

Outlays for new construction in 1957 totaled $47.3 billion—about 3 percent above the record $46.1 billion spent in 1956, according to preliminary joint estimates of the U. S. Departments of Labor and Commerce. Expenditures were at peak levels in 1957 for a large majority of the major types of private and public construction, but there was a narrowing of year-to-year gains for some important components.

Primarily because of the decline in private dwelling construction, last year's over-all rate of increase in total construction activity was the smallest in the twelve years since the end of World War II. The physical volume of new construction (expenditures adjusted for price changes) was about the same as in 1956. However, when private residential building is excluded, the constant dollar value (in 1947-1949 prices) was up 3 percent. The record $33.3 billion spent for private construction was only slightly above the 1956 figure, whereas public outlays rose 9 percent to a new high of $13.9 billion.

New private housing activity, influenced by a shortage of mortgage funds, declined by 10 percent in 1957, to $12.2 billion, about the same relative decrease as occurred in 1956. By the middle of the year, however, the two-year slide in private residential construction appeared to be checked, and outlays (seasonally adjusted) rose steadily through the end of the year, largely on account of the rise in apartment building.

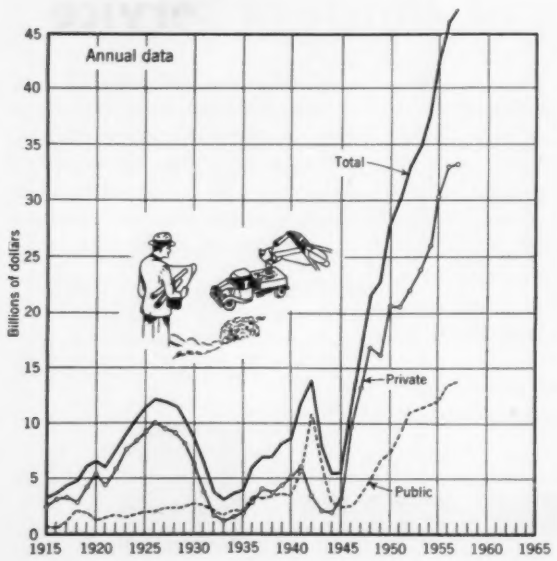
The $1.3-billion drop from 1956 to 1957 in new private housing outlays was offset by gains in all other types of private work except store and school building. Expansion by public utility companies accounted for the largest dollar increase in the private sector during 1957. Total utilities expenditures rose by $717 million to a record $5.8 billion. The sharpest percentage gain in private work was shown by hospital and institutional building, which rose 54 percent over the year to a record high of more than a half billion dollars. Other types of private construction achieving an unprecedented dollar volume were religious building and social and recreational facilities. Private school building declined a little from the record set in 1956.

The three-year expansion in private industrial plant construction leveled off in 1957 as production capacity in many cases caught up with demand. Outlays for new structures totaled a record $3.2 billion in 1957, but the year-to-year gain was only 3 percent, compared with 29 percent in 1956. Store building reversed a four-year trend by declining 12 percent in 1957. Though office building expanded for the fifth successive year to a new peak, the rate of increase was less than half that shown in 1956.

Highway construction and school building contributed most to last year's $1.1 billion increase in the public total. Spending for road construction advanced 8 percent over the year to $4.8 billion, reflecting mainly an increase in work put in place on federally aided state highways. State toll road construction, which reached a peak in 1956, declined in 1957. Public school building scored an 11-percent rise to $2.8 billion—2½ times the gain shown between 1955 and 1956.

Almost all other public construction categories also showed increases from 1956, with the largest percentage gain (75 percent) in public housing. Outlays for public hospital and institutional buildings showed an upturn for the first time in six years, and spending for administrative and service buildings was boosted by expansion in both federal and state and local projects. The 1956 up-turn in conservation and development work continued in 1957. Public service enterprises edged up to a new record because of gains in airfield construction.

Outlays for sewerage facilities expanded to a new high in 1957, though at a somewhat slower rate than in 1956, and water works construction was down for the first time in the post World War II period. Expenditures for construction done at military installations declined 9 percent last year—reflecting primarily completion of projects begun in 1955 and 1956. Federal spending for industrial plants (mostly atomic energy facilities) was virtually unchanged last year, amounting to about a fourth of the amount spent in 1953, the postwar peak year for this category.



Construction activity for 1957 breaks dollar-volume record for the twelfth consecutive year with total outlays of $47.3 billion—an increase of about 3 percent over 1956. Physical volume was about the same as 1956.

Electronic Computer Program Library

The Federal Highway Administrator has established an Electronic Computer Program Library in the Bureau of Public Roads to serve as a central point for receipt and distribution of computer programs developed for use in the highway field. It is expected that the library will minimize duplication and expedite the development of computer applications. Each program received for the library is edited to delete terminology peculiar to the computer for which it was developed and to assure clarity. The final library version, expressed solely in English and mathematical terms, can be coded for use with any digital computer.

For the convenience of state highway departments, consulting engineers, and others interested in the use of electronic computers in highway work, a series of memoranda will be issued periodically to provide information on programs and other pertinent developments. Memorandum No. 1, currently available, may be obtained from the Bureau of Public Roads, Office of Operations, Division of Development, Washington, D. C.

Adhesives and Sealants in Modern Construction

The merits, shortcomings, and future potential of adhesives and sealants in all types of building were debated at a recent two-day conference sponsored by the Building Research Institute for its members and the general public. Over 400 attended the conference, which took place in Washington, D. C. Conference chairman was Clayton S. Myers, project manager of the Bakelite Company.

The opening session dealt with the basic properties of adhesives, sealing compounds and tapes, and pre-formed gasketing materials and tapes. This was followed by a two-part session devoted to traditional materials and to metal curtain walls. Another two-part session was concerned with cementitious materials and lumber products and with sandwich panels.

In the keynote speech, Albert G. H. Dietz, A.M. ASCE, professor of building construction at Massachusetts Institute of Technology, emphasized the importance of engineering sealants and adhesives to the new construction. One of the major advantages of adhesives over conventional bonding agents is that they are more rigid and permit a continuous bond. Weight saving was cited as another important advantage. Because of their elasticity adhesives are particularly useful for binding together different materials that have different coefficients of expansion. The major drawback to the use of adhesives bonds is that they fail if improperly used and applied. It was stressed that extreme care must be taken to select the correct adhesive for the job at hand.

Among the applications discussed for interior building were floor surfacing materials, walls, ceilings, and work surfaces, and building service systems. Future uses will include tapes for joining building panels, which are being developed now.

The Building Research Institute was set up in 1952 to meet the need of the construction industry for an organization that could focus the attention of the entire industry on building research technology. It is a unit of the National Academy of Sciences-National Research Council. C. H. Topping, M. ASCE, of Wilmington, Del., is current president.

Approaches for Lower Deck Of George Washington Bridge

The New York City consulting firm of Ammann & Whitney has been retained by the Port of New York Authority to design the New Jersey approaches to the six-lane lower deck of the George Washington Bridge. The firm will provide design services, under a cost-plus-fixed-fee agreement not to exceed $1,350,000, for eight New Jersey approach contracts for the second-deck project at Fort Lee. O. H. Ammann, Hon. M. ASCE, original designer of the bridge and chief engineer of the Port Authority during its construction over a quarter of a century ago, has been serving since August as design consultant on the second-deck structure. Allowances for a second deck, when warranted by traffic conditions, were made in the original foundations, towers, cables, and suspender system.

Construction is scheduled to start this coming summer, with the lower deck opened to traffic in 1962. The cost of the second deck and the approaches is estimated at $182,000,000.

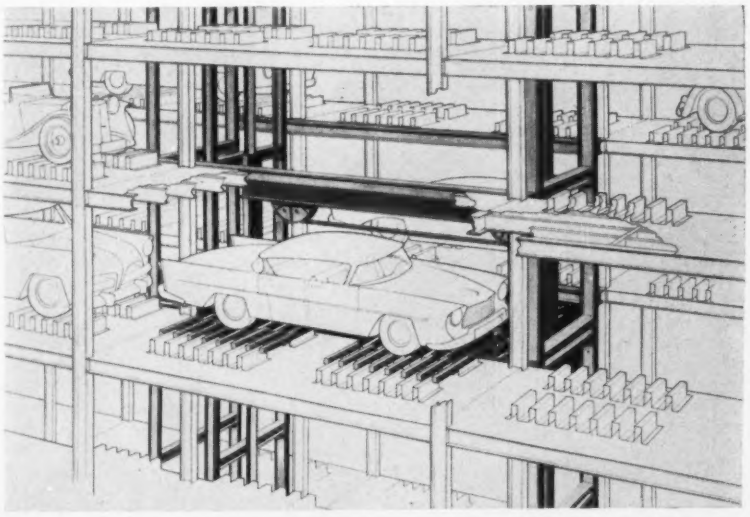
New York to Have Automatic Parking Garage

New York City will have the world's first completely automatic parking garage, to be built on a mid-town site and owned by Columbia University. The eight-story garage will house 230 automobiles and provide reservoir parking facilities for an additional 46. Completely automatic in all respects, the garage will noiselessly park or discharge as many as three cars a minute. The single attendant will act solely as cashier.

This is how automatic parking is done. When the motorist arrives, the cashier removes a numbered key from a central control panel and hands it to him as his parking "receipt." Simultaneously an individual meter begins recording the time and corresponding charge for the "locker" to which the car has been assigned. An elevator door opens, and the car is picked up under the tires by a conveyor and moved laterally into the elevator. The door closes and the elevator proceeds to the proper floor, where the car is automatically transported to the locker whose number is on the key in the motorist's possession. On returning to the garage the motorist gives his key to the cashier, who replaces it in its original position in the control panel. The discharge process (the parking process in reverse) is instantly initiated, and proceeds while the cashier is collecting the metered fee.

The revolutionary parking process is the invention of Mihai Alimanestiano, civil and mechanical engineer and president of Speed-Park, Inc. Associated with Speed-Park in the venture is the Otis Elevator Company, which will manufacture, install, and maintain all equipment and controls contained in the structure.

The Columbia University garage will be the first of a series to be built in major cities throughout the country. Capacities will range from 60 to 2,000 automobiles.



Patented method of parking is pictured here in close-up. Car is seen entering its parking "locker," transported on the steel fork-lift conveyor projecting from the open elevator shaft. One elevator serves both rows of lockers shown in the sketch, traveling horizontally the length of the building as well as vertically to all eight floors. Moving parts are indicated in dark grey.

Connecting Steel Placed in Greater New Orleans Bridge

Completion of the Greater New Orleans Bridge across the Mississippi moved a step closer on January 3 when the Bethlehem Steel Company united the two cantilever arms, reaching toward each other across the river, with a 100-ft, 36-ton fabricated chord section. The main span of 1,575 ft is the third longest cantilever span in the world, surpassed only by the Quebec Bridge across the St. Lawrence and the Firth of Forth Bridge in Scotland. The anchor spans are 853 and 591 ft long. Because of the difference in their length, the roadway of the shorter span will be floored with a 7½-in.-thick concrete slab to provide the additional weight needed to balance the cantilevered section. The remainder of the bridge will be floored with steel grating covered with a bituminous concrete riding surface. Modjeski and Masters are the engineers and designers for the bridge, which is being built by the Mississippi River Bridge Authority. Bethlehem Steel's contract is for $12,268,850.

Consultant Held Not Subject to Fair Labor Standards Act

In a recent significant ruling, a federal court upheld the contention of a Virginia engineering firm, with a branch office in Washington, D. C., that it is not subject to the over-time requirements of the Fair Labor Standards Act with respect to its non-professional employees. The ruling is based on the theory that the firm is not engaged in interstate commerce or in the production of goods for commerce.

The Labor Department had previously sought an order to make the firm—Lubin, McGaughy & Associates, of Norfolk—comply with the law. It contended that the firm is engaged in commerce across state lines, that it produces plans and specifications that are "goods for commerce," and that its work on highways and airports is so closely associated with commerce as to be part of it.

In rejecting these arguments, the court ruled that the firm "is not employed to manufacture documents to be sold or transported in interstate commerce, but to give professional advice and assistance which of necessity was given permanent form as plans or specifications so as to be available for guidance and reference."

The decision was handed down by the Circuit Court of Appeals for the Fourth Circuit.

The decision has an important bearing on a test suit being brought by the Labor Department against the consulting firm of Singstad & Baillie—as one of the engineering groups engaged on the $132,000,000 Baltimore Harbor Crossing Project—to force it to comply with the Wages and Hours Act. The suit will be tried first in a U.S. District Court in Maryland. Its implications in connection with the interstate highway program are obvious.

It will be recalled that in 1948 the Federal Court of Baltimore ruled that the Fair Labor Standards Act did not apply to professional architects and engineers and their staffs of technically trained employees. This decision was rendered by Judge W. Calvin Chestnut in injunction proceedings filed by Wage and Hour Administrator William R. McComb against the Baltimore consulting firm of Turpin, Wachter & Associates, in an attempt to make the firm pay overtime compensation to its employees and keep employment records.

Connecticut Turnpike Opened to Traffic

The $464,000,000 Connecticut Turnpike was formally opened to traffic on January 2 in ceremonies headed by the governor of the state, Abraham A. Ribicoff. Ribbon-cutting ceremonies took place at each end of the 129-mile through road, which extends from Greenwich at the New York State line to Killingly on the Rhode Island border. Newman E. Argraves, M. ASCE, state highway commissioner, received special praise during the ceremonies for getting the important project done on schedule.

Providing from two to eight traffic lanes, the new toll road is expected to relieve congestion on the Boston Post Road and to open up the eastern part of the state to commercial and industrial development. However, the full benefit of the turnpike will not be felt until 1959, when it will be connected with the New England Thruway at Port Chester, N. Y. Some 8,000,000 automobiles are expected to use the new route annually.

At each of the seven toll stations on the turnpike a charge of 25 cents will be made for passenger cars. Truck charges will be higher. An eighth toll station, at Greenwich, will be opened when the connection to the New England Thruway is completed. It is estimated that construction costs will be liquidated in 40 years.

To assure finishing the road by the December 31 target date, more than 70 prime contractors and innumerable subcontractors had a hand in the project. The Connecticut Highway Department handled the overall engineering, with many consulting firms doing sections of the work. The largest bridge, over the Quinnipiac River at New Haven, is described in this issue.

Missile Bases to Guard New England

One of the most advanced weapons in the country's arsenal—the U.S. Air Force's surface-to-air missile IM-99 Bomarc—will soon be installed near Dow Air Force Base at Bangor, Me., and at Otis Air Force Base on Cape Cod. Announcement of these installations to guard New England cities and industries was made recently by the New England Division of the Corps of Engineers, which has awarded a contract to Fay, Spofford & Thorndike, Inc., of Boston, and Alonzo J. Harriman, of Auburn-Lewiston, Me., for planning and engineering the $12,000,000 site in Maine.

Site clearance for the Bangor installation was started in December, and the base is expected to be in operation by 1960. The Corps of Engineers will ask for construction bids this spring.

Creative Trends in Structural Design Studied

More than 700 enthusiastic engineers and architects, constructors and educators gave their close attention to a two-day structural conference held in Chicago's Congress Hotel in December. The hotel's Glass Hat Room was filled to overflowing. In two adjoining rooms, the overflow of 200 persons listened and watched by closed-circuit television facilities.

What will be the dominant feature of tomorrow's buildings: their shape and form; the materials they use; and the methods of design and construction? How will these shapes, materials, and methods be applied to structures for the use and comfort of man? These were the questions to which the twenty speakers addressed themselves at the Third National Construction Conference. The conference was sponsored by Armour Research Foundation of the Illinois Institute of Technology.

In welcoming the visitors, Dr. Haldon A. Leedy, director of the Foundation, named two obstacles to any creative trend: the first, cost; the second, convention. "People must be educated to accept tomorrow's designs and materials," he said. The construction industry must pave the way for public acceptance of new concepts. "Many of the answers . . . will be found in research. Research is creative. Its results establish trends."

Breaking with convention, Walter W. Bird described the air-supported membrane-fabric structures, manufactured by his company, to provide cover and shelter for such structures as military installations and swimming pools. A weather-resistant structure of this type is normally supported by air pressures equal to about 2 in. of water. A strength of from 20 to 50 lb per inch of width of fabric is built into the material. To withstand a 125-mph wind the pressure is increased to 7 in. of water.

Felix Candella, well-known Mexico City designer and builder, presented strikingly new thin-shell concrete structures of hyperbolic paraboloid shapes. Fred N. Severud, M. ASCE, member of the New York firm of Severud, Elstad, Kreuger, described a number of cable-tied structures already designed and built by his firm, and explored the possibility of building still larger cable-supported roofs for stadiums and rinks. Anton Tedesko, M. ASCE, vice-president of the Roberts and Schaefer Co., pointed out the cost advantages in the United States of singly curved concrete-shell structures which can be formed on easily built and easily moved centering. "Here, we may accept penalties in material quantities as long as there are savings in labor involved," he pointed out. "Where cost is not the prime consideration, the scope of shells is unlimited." Robert J. Hume, who currently heads the national program for the sale of aluminum domes for Kaiser Aluminum and Chemical Sales Inc., presented a movie showing the construction of the Kaiser dome auditorium in Hawaii—a 16,000-sq ft structure, with a capacity of 2,000 people. D. L. Richter, design engineer for Kaiser, explained the many applications of this Fuller geodesic principle to structural domes. A unique method of erecting a Kaiser-fabricated dome on inflated balloons is shown in the January issue (page 93).

Among the newer materials, lightweight-aggregate concrete has advantages for precasting and prestressing. Joseph J. Shideler, of the Portland Cement Association, explained these advantages. Materials reinforced with glass fibers are coming into use for sandwich plates, and for many other building elements, according to Gen. B. S. Kelsey (USAF, Ret.), technical consultant to the Owens-Corning Fiberglas Corp. C. Robert Lillie, researcher in nonferrous metals for the Armour Research Foundation, spoke of the several lightweight metals, such as aluminum, magnesium, titanium, which are available for structural use. "New Developments in Timber" was the subject of an enlightening paper by Elon E. Ellis, vice-president of Timber Structures, Inc., of Portland, Ore.

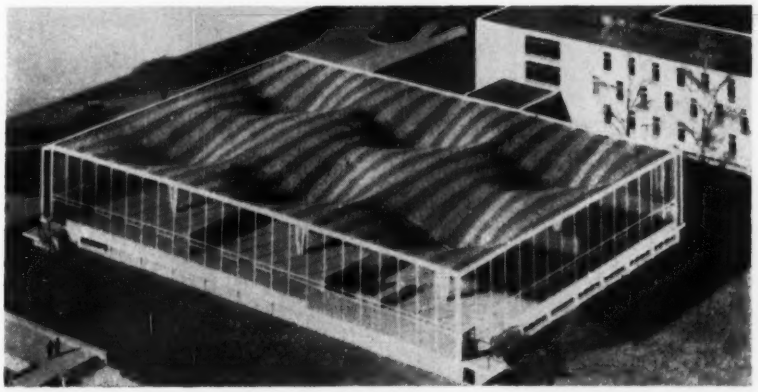
Prof. Lynn S. Beedle, M. ASCE, of Lehigh University lectured convincingly on the theory and practical advantages of designing steel structures by the plastic theory as opposed to the elastic theory. This was followed by an equally instructive lecture, by Eivind Hognestad, M. ASCE, of the Portland Cement Assn., on designing structural concrete by the ultimate-strength method. Prof. August J. Durelli, eminent in the fields of stress analysis, three-dimensional photoelasticity, and dynamic testing of models, explained the tests recently made at Armour on a plastic model of a buttress-type dam.

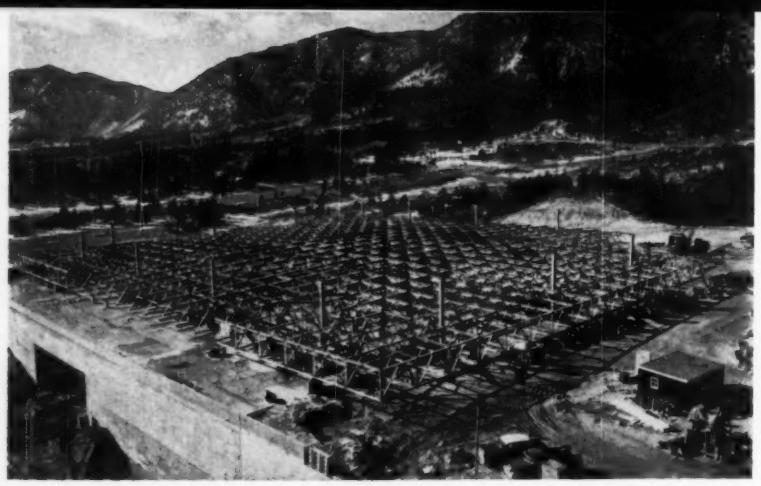
Electronic computers, rapidly coming into use in design offices, have a great potential in structural design procedures, according to James H. Turnock, Jr., field manager of applied science for I.B.M. The American Bridge Co. is among the pioneers in the use of high-speed computers for bridge design, according to C. W. Zahler, M. ASCE, of the U. S. Steel Co. He pointed out that computers have been found to be reliable; they save time and money, and promote the general welfare of engineers using them.

The papers presented at the conference are expected to be available in printed form from Armour Research Foundation, 10 West 35th St., Chicago 6, Ill. The carefully scheduled program for the conference was arranged by David B. Singer, of the Foundation's research staff.

"Inverted Umbrella" Roof Designed for College Library

Hunter College Library—under construction on the college's Bronx campus in New York City—will be one of the nation's first educational institutions to feature hyperbolic paraboloid roof design. Resembling inverted umbrellas, the hyperbolic paraboloid shapes will be made of thin concrete shells insulated with lightweight perlite concrete. Only six columns will be required, one to support each of the six 60-ft by 60-ft shapes. The large interior spaces provided by the long spans will afford maximum floor space with minimum obstruction of view. The radical construction concept is a recent Mexican development. Upon completion in 1959, the dramatic-looking 120- by 180-ft structure will be a 230,000-volume library. Architect Marcel Breuer designed the structure for the Board of Higher Education of New York City. Frakas & Barron, also of New York, are the structural engineers.



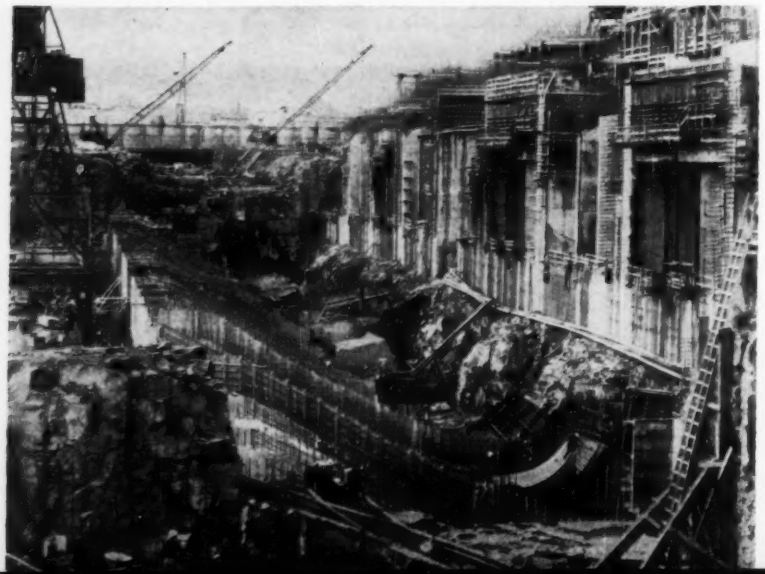


Roof at Air Force Academy Raised as One Unit

Unique roof-raising operation recently took place at site of new Air Force Academy near Colorado Springs. In the biggest lifting operation of its kind ever attempted, the American Bridge Division of U. S. Steel raised the 1,150-ton, 308-ft-square steel grid roof of the new cadet dining hall some 24 ft from temporary blocking on the floor slab. Twenty-four hydraulic jacks raised the roof in small lifts, each increment held by nuts turned by hydraulic means on the lifting rods attached to the roof beams. The entire operation was handled by remote control and took about six hours. The method was chosen instead of conventional roof-raising processes because of the unusual degree of accuracy specified. It is thought to be the first use of the lift-slab technique for raising a steel-truss roof. Col. A. E. Stoltz is director of the Air Force Construction Agency, and the firm of Skidmore, Owings & Merrill is the architect. The Vagtborg Lift Slab Corp., of Los Angeles, did the actual raising for the American Bridge Division of U. S. Steel.

Construction of Priest Rapids Project Is Pushed

Construction of Priest Rapids Dam on the Columbia River in Central Washington is one-third complete. About $38,615,000 was spent on the project in the past year, and it is estimated that $45,682,000 will be expended in 1958. Plans for 1958 call for completing the 1,025-ft-long powerhouse to a point where installation of turbines and generators can begin. Two more generators will be added to the eight originally planned. They will add 166,000 kw of peaking capacity to the name-plate total of 630,000 kw for the first eight units. First commercial power will come off the line about July 1960. Water-intake structures of the powerhouse loom at right in this photo, and the draft-tube exits are at left center. The Harza Engineering Company, of Chicago, is in charge of the design and supervision of construction of the Priest Rapids Project. The Merritt-Chapman & Scott Corporation is the contractor for the Public Utility District of Grant County.



1957 Steel Output Is Third Highest on Record

Steel furnaces in the United States turned out 112,707,711 tons of ingots and steel for castings during 1957—a total exceeded in only two other years, according to a preliminary report of the American Iron and Steel Institute. The nation's third highest annual output, this production compares with the 1955 record production of 117 million tons and the 1956 output of 115.2 million tons.

The December 1957 output was 7,413,000 tons, a drop from the November production of 8,392,919 tons. The output for the last quarter of the year was 25,003,636 tons, against 27,120,528 tons in the preceding quarter.

Steel capacity rose in 1957 to a record high of 140,742,570 net tons—an increase of about 7.3 million net tons above the level of a year ago. The operating rate for 1957 was 84.5 percent of capacity, based on the January 1, 1957, rate of 133,459,150 tons.

The American Iron and Steel Institute announces that hereafter it will eliminate its weekly reports of operating rate in favor of an estimate of actual output. Since steel producers gear their weekly production to current and foreseeable demand, the weekly percentage figure has been looked on as a kind of industrial gauge. With the constant increase in steel capacity, however, it is believed that use of the operating rate as an index tends to make conditions in the steel industry seem worse than they are.

Bosporus Bridge to Link Europe and Asia

D. B. Steinman, New York City consulting engineer and bridge authority, has been selected by the Government of Turkey as the engineer to design and supervise construction of its $50,000,000 suspension bridge across the Bosporus at Istanbul. The structure will join Europe and Asia, making it the world's first intercontinental bridge. The four-lane highway bridge will have a main span of 2,214 ft, longest in the world outside the United States. Its overall length will be 4,496 ft.

The contract includes 1½ miles of approach highways with five interchange structures. To accommodate international shipping, a vertical clearance of 164 ft will be provided for a distance of 1,312 ft. The two main piers will be built in the turbulent waters of the Strait. The water at the pier locations is over 130 ft deep.

Two Gurley transits feature built-in optical plummets

Gurley OP-57

Gurley OP-137

The Gurley Optical Plummet Transit (Model OP-57) has proved itself to be such an important time and money saver in the field that this optical plummet feature has also been added to the Model 132 Standard Precise Transit. The new transit will be known as the OP-137.

Both these Optical Plummet Transits will save you time and trouble in setting over a point. The OP-57 and OP-137 eliminate the swing and sway of the cord and plummet—exasperating and time consuming. You will especially appreciate the increased accuracy on windy locations.

By rotating the instrument 180°, you can be assured of positive centering.

The Gurley Optical Plummet Transits are furnished with tripods which have built-in shifting heads. They allow a two-inch shift of instrument over the point, providing greater latitude in initial set-up.

Model OP-57 is recommended for very exacting work; the OP-137 for general engineering and construction work because of its shorter telescope, smaller size and its lighter weight.

Now in *two* models Gurley offers you an important advantage of the optical-reading theodolite *plus* the simplicity, ruggedness and proved performance of the American transit. *Write for new Bulletin OP-100.*

GURLEY

W. & L. E. Gurley

Engineering Instruments Division

518 Fulton Street, Troy, New York

Since 1845

Virginia City Water Works to Be Repaired

More money will be invested in the Virginia City (Nev.) water works—a $7,000,000 supply system built in the boom days of the seventies to serve a population of from 20,000 to 40,000. Today it serves fewer than a thousand people. Curtiss-Wright, new owner of the Virginia City and Gold Hill Water Company, will undertake extensive rehabilitation of the historic system in order to insure a continuing adequate water supply. The project will include extensive repairs to the distribution system where serious leakage has been reducing the water supply.

The historic background of the pioneer Virginia City water works was the subject of an interesting article by C. E. Painter, M. ASCE, in the September 1957 issue.

Aluminum Reported In Ample Supply

The aluminum industry can chalk up 1957 as the third successive year in which primary aluminum production in the United States was in excess of a million and a half tons. Primary aluminum production during the year totaled some 1,640,000 tons, which was about 38,000 tons below the 1956 output. Even so, 1957 was the first year in which aluminum supplies caught up with and exceeded demand.

According to the Bureau of Mines statistics, imports of bauxite for U.S. consumption were 11 percent higher for the first half of 1957 than for the same period last year. Most of the imported raw material came from Surinam (Dutch Guiana) and Jamaica. The supply from the United States mines was down 23 percent from 1956. Of the domestically mined bauxite, 97 percent came from Arkansas.

Any Books You Care to Spare?

Here is a chance to prune your library of unwanted volumes while contributing to the education and pleasure of others. The Asia Foundation is soliciting books at university and college level in every category. Works by standard authors will be especially welcome, as will volumes published within the past ten years. They should be in good condition. Transportation costs for substantial shipments will be borne by the Foundation.

The Asia Foundation is a non-profit, non-political organization formed by private American citizens to support individuals and groups in Asia who are working for the attainment of peace and for social progress. In the past two and a half years the Foundation has sent 600,000 selected books to more than 1,200 universities, colleges, libraries, and civic groups. These volumes were donated by 700 university and college groups, publishers, libraries, and individuals. The great need for books continues, as evidenced by the ever increasing number of requests.

Inquiries and books should be sent directly to Books for Asian Students, 21 Drumm Street, San Francisco 11, Calif.

Graduate Scholarships Listed

A survey of graduate scholarships, fellowships, and assistantships available to civil engineering students in 1958 has been prepared by Chi Epsilon, national civil engineering honor fraternity. Copies of this detailed report of opportunities for advanced study have been sent to the civil engineering departments of all American and some foreign colleges and universities. The graduate programs include over 500 individual awards.

Single copies of the survey are available upon request as long as the supply lasts. Inquiries should be addressed to Michael A. Spronck, Member, Supreme Council, Chi Epsilon, Martinsville, N.J.

N * G * Neare's COLUMN

R. Robinson Rowe, M. ASCE

"Well, Joe," asked the Professor, "Which starved to death, the folves or the woxes? Or was Uterivoria overrun by them?"

"The folves," declared Joe Kerr, "but it was nip and tuck for awhile. At the start, there were 1,200 folves and only 1,000 woxes. In the first year, the 6% and 7% birthrates added 72 folves and only 70 woxes, but the folves ate only 48 woxes while the hungrier woxes ate 50 folves. So each gained 22, and I guessed the island would be overrun.

"Figures are funny, tho. After 20 yr figured like that, there were as many woxes as folves (1640) and they were increasing 3 times as fast. After 28 yr, more folves were being eaten than born. I kept figuring to the 45th year, when I ran out of folves—all et up!"

"Joe missed the point," jeered Cal Klater, "even tho his figures are a fair approximation of the facts. Taking the time t in centuries to avoid fractions, the basic relations of folves f and woxes w was given as:

$$\dot{f} = 6f - 5w \qquad f_o = 1{,}200 \quad \ldots \quad (1)$$

$$\dot{w} = 7w - 4f \qquad w_o = 1{,}000 \quad \ldots \quad (2)$$

First adding (1) and (2), and letting $w + f = p$, the total animal population:

$$\dot{p} = 2p \qquad p_o = 2{,}200 \quad \ldots \quad (3)$$

$$p = 2{,}200\, e^{2t} \quad \ldots \quad (4)$$

Next dividing (1) by (2),

$$\frac{df}{dw} = \frac{6f - 5w}{7w - 4f} \quad \ldots \quad (5)$$

Which can be integrated to find

$$\frac{5w - 4f}{200} = \left(\frac{w + f}{2{,}200}\right)^{4.5} \quad \ldots \quad (6)$$

Then, combining (6) with (4),

$$5w - 4f = 200\, e^{11t} \quad \ldots \quad (7)$$

Obviously, with the right member always positive, w never becomes zero. So when $f = 0$, $w = p$, and using (4) again,

$$w = 40\, e^{11t} = p = 2{,}200\, e^{2t}$$

$$e^{9t} = 55$$

$$t = \frac{1}{9} \log 55 = 0.44526$$

Being in centuries, this is 44.526 yr from now, or in the summer of . . . ."

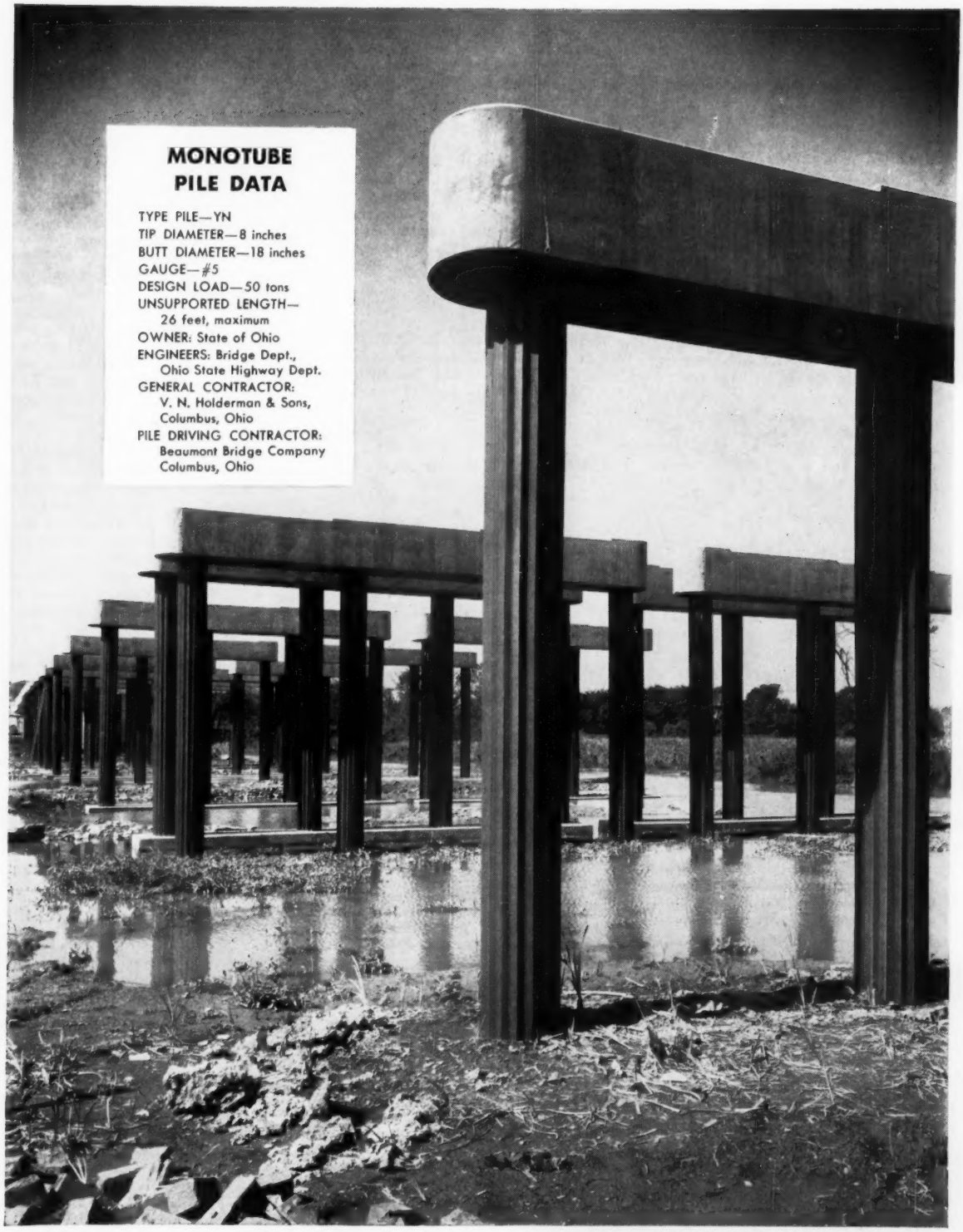
"Then why am I wrong," muttered Joe. 'I had $f = 0$ in the 45th year, same as you!"

". . . AD 2002 when the *woxes* starved to death."

"Precisely," agreed Professor Neare. "Joe wasn't wrong, but Cal pointed out that he hadn't answered the real question, as an excuse for Cal to display his mathematical elegance. I let him do it because his method will help solve the sequel with 3 kinds of animals.

"Let's call them xabs, yefs and zops, for you know why. Initially there were 936 xabs, 1,118 yefs and 962 zops stranded on the island. Birth rates were 8% for xabs and zops, and 7% for yefs. Xabs subsisted only on zops, at the rate of .05 zop per xab per yr. Yefs lived on .04 xab per yef per yr, and zops on .05 yef per zop per yr. This convenient tho monotonous fare is common in nature, often leading to starvation of the prolific, extermination of the more continent, survival of the fittest, suicide of lemmings, etc. What was the fate of the xabs, the yefs and the zops?"

[*Cal Klaters were: H. Francis Finch, Philip (and partly George) Thacher, James M. Gere, H. J. Rhodes, and Rudolph W. Meyer. Also acknowledged are solutions of the October ladder problem from Ti Huang and Walter J. Tudor.*]



VERSATILITY plus ECONOMY with Monotube piles. When soil conditions at this site in Mansfield, Ohio, prohibited conventional construction in crossing low-lying land, this adaptation of a foundation supported on Monotube steel piles proved to be an economical solution.

Tapered, fluted Monotube piles are available in lengths, diameters and gauges to meet every requirement. Write The Union Metal Manufacturing Co., Canton 5, Ohio, for complete information.

UNION METAL

Monotube Foundation Piles

DECEASED

David W. Bainbridge (A.M. '24), age 63, engineer for Springfield Township, Pa., for 27 years, died at his home there recently. Early in his career, Mr. Bainbridge was a construction engineer with Charles F. Puff, Jr., of Jenkintown, Pa.

Howard Carter Baird (M. '04), age 89, retired consulting engineer and specialist in bridge building, died on December 5 in Highland Park, Ill., after a long illness. Mr. Baird was in consulting practice in New York City for many years, for almost thirty years as a member of the firm of Boller & Hodge. The many projects with which he was identified included the Bear Mountain Bridge over the Hudson and the St. Louis Municipal Bridge across the Mississippi.

Mervin J. Barrick (A.M. '32), age 69, consulting sanitary engineer in Williamsport, Pa., died on November 29. Prior to his work as consultant, Mr. Barrick served as chief of the Sanitary Control Section of the Pennsylvania Department of Health at Williamsport and in other capacities with the department. He was graduated from Pennsylvania State College.

Ronald M. Beck (A.M. '22), age 72, district construction engineer for the New Jersey State Highway Department at Belleville, died on December 22. Early in his career, Mr. Beck served the New York and New Jersey Bridge and Tunnel Commission as assistant engineer.

Thomas M. Brassel (A.M. '21), age 65, engineer and lawyer, died in New York City on December 25. Mr. Brassel, who received his L.L.B. from Fordham University in 1917, did legal work for engineering firms. At one time he was in the chief engineer's office of the New York City Transit Construction Commission.

Tracy A. Buie (A.M. '46), age 57, urban engineer with the Louisiana Department of Highways at Baton Rouge, died on November 28. Mr. Buie, a veteran of thirty-five years' service with the department, was a recognized authority on urban highway planning in the South. He was a graduate of Georgia Institute of Technology.

Ray S. Carberry (M. '21), age 84, retired engineer of Riverside, Calif., died on December 8. Mr. Carberry had served the California Department of Public Works as senior hydraulic engineer, the California Division of Water Resources, and had made a special hydrographic report for the Federal Land Bank. Prior to his retirement, Mr. Carberry was area conservationist for the Soil Conservation Service in northern Nevada. Mr. Carberry held a B.S. in civil engineering from the University of Illinois.

Carl Alexius Carlson (M '12), age 81, retired Captain in the Civil Engineer Corps at Oakland, Calif., died recently. Captain Carlson was a civil engineering graduate of Case School of Applied Science. Commissioned as a lieutenant in the Navy in 1903, he had served at a number of posts.

William H. Collisson, Jr. (A.M. '19), age 70, consulting engineer of Ocean City, N.J., died recently. From 1925 to 1948, Mr. Collisson was city engineer for Ocean City.

Carl deMoll (M. '20), age 86, engineer and architect, and a partner in the Ballinger Company of Philadelphia, Pa., since 1926, died on January 2. Mr. deMoll began his professional career with Ballinger and Perrot, predecessor firm to the Ballinger Co.

Edgar D. Gilman (M. '22), age 69, director of public utilities for Cincinnati, Ohio, from 1926 until his retirement recently, died on October 21. Earlier Mr. Gilman taught at the Universities of Cincinnati and Minnesota, and worked as structural designer on Ohio River locks and dams. Mr. Gilman was graduated from the University of Wisconsin.

John Guy Glasgow (M. '26), age 73, retired manager of engineering for the Gulf Oil Corporation of Pittsburgh, Pa., died recently. A refinery engineer, Mr. Glasgow had been with the Gulf Refining Company for many years. He was a graduate of Pennsylvania State College.

Frederick R. Haddock (M. '37), age 64, chief engineer for Roberts Filter Manufacturing Company, died recently at his home in Philadelphia. A graduate of the Drexel Institute, Mr. Haddock had been with the company since 1910.

Thaddeus L. E. Haug (M. '26), age 72, senior designing engineer for the East Bay Municipal Utility District in Oakland, Calif., died recently. Prior to 1933, when Mr. Haug began his work for the Utility District, he served as structural and design engineer for a number of California firms. He designed and patented a special support for long-span pipe lines.

Normond S. Holroyd (M. '44), age 54, since 1943 consulting engineer and partner in the Troy, N.Y., firm of Keis & Holroyd, died on December 28. Mr. Holroyd was a graduate of Rensselaer Polytechnic Institute.

John E. Keranen (M. '47), age 58, chief structural engineer for the Corn Products Refining Company, Chicago, Ill., died in Clarendon Hills, Ill., on December 11. With the Corn Products Refining Company since 1929, Mr. Keranen had served on many important design and development projects. He was a graduate of the State College of Washington, and had an M.S. from the University of Illinois.

Cosmo M. Knez (A.M. '34), age 61, structural engineer with the New York City Department of Public Works since 1939, died on November 17. Mr. Knez was graduated from the Archduke Joseph Polytechnic Institute in Budapest.

William S. Lozier (M. '19), age 81, for many years president of William S. Lozier, Inc., civil and sanitary engineers of Rochester, N.Y., died on December 6. Prior to the formation of his own firm, Mr. Lozier had served as assistant professor of sanitary engineering at New York University, and chief project engineer with the U.S. Shipping Board. He was a graduate of Rensselaer Polytechnic Institute.

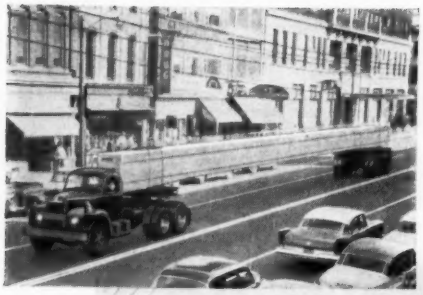
Frank Ray McFarland (M. '39), age 63, division manager of Sheffield Steel Corporation in Houston, Tex., died there recently. Connected with Sheffield Steel for many years, Mr. McFarland served as superintendent of construction on many important projects, and was chief engineer in charge of constructing the Houston plant. Mr. McFarland was a graduate of Washington University.

Paul Joseph Neff (M. '47), age 73, president and chief executive officer of the Missouri Pacific Railroad, with headquarters in St. Louis, Mo., died there recently. A graduate of Kansas University, Mr. Neff began his railroading career with the St. Louis-San Francisco Railroad, and subsequently served the Wichita Falls, Ranger & Fort Worth Railroad, and the International-Great Northern Railroad. He began his career with Missouri Pacific in 1926.

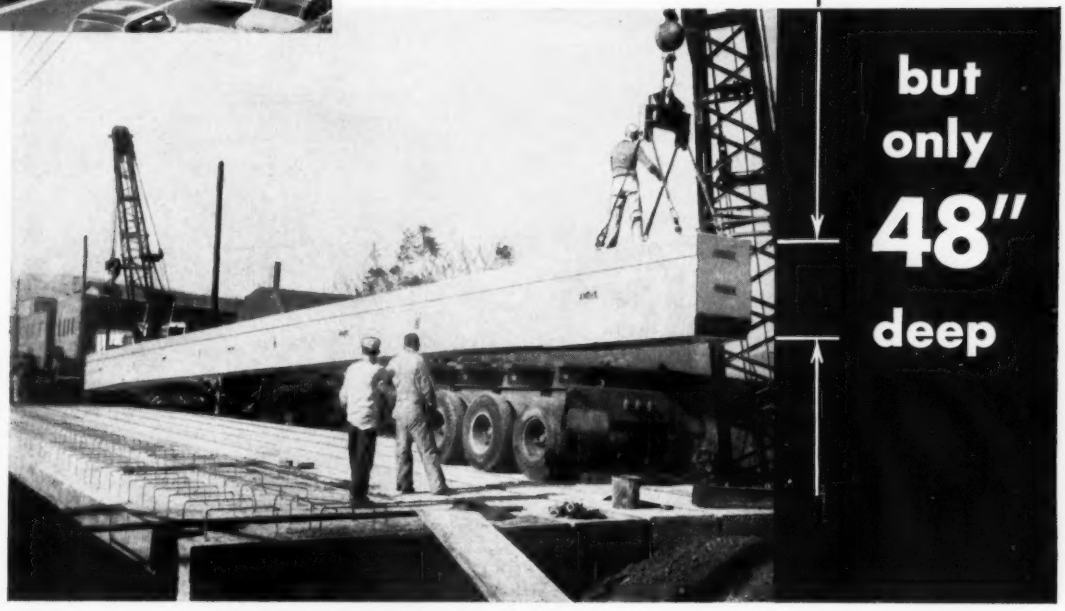
Edward P. Quirk (M. '41), age 70, engineer with Ebasco Services, Inc., of New York City, died there recently. Prior to his work at Ebasco, Mr. Quirk was valuation engineer with the New York State Public Service Commission.

Toivo W. Ranta (A.M. '37), age 52, location engineer for the U.S. Bureau of Reclamation in Huron, S.Dak., died there recently. A specialist in topographic mapping and surveying, Mr. Ranta served the U.S. Geological Survey for many years on projects in the United States and Alaska. He was a graduate of the South Dakota School of Mines.

(Continued on page 110)



Over 100 feet long...



AMDEK Prestressed Pretensioned Concrete BRIDGE SUPERSTRUCTURES

Fast, trouble-free erection of Amdek concrete bridges has resulted in their widespread acceptance by highway officials, engineers, contractors and the public. Depend on Amdek to provide superior structures on schedule and at low cost.

A "traffic stopper" only on the way to the job, these 103′ lengths of Amdek linear prestressed beams actually prevented a long traffic tie-up for the City of Scranton, Pa. by cutting bridge building time to a few days. And, in spite of their record length, these Amdek members are only 48 inches deep—a minimum depth-to-span ratio that means less weight plus the economies of greater clearance and reduced fill. Amdek linear prestressed beams were selected for this bridge over all other designs because of lower cost . . . speed of erection . . . ready availability of materials and ease of delivery. Before building *your* new bridge, consider these important advantages of Amdek—and write for colorful new brochure illustrating other outstanding features.

Another example of Progress in Concrete

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MID-WINTER CONSTRUCTION AND LEHIGH EARLY STRENGTH CEMENT

• Year after year, construction work becomes less seasonal, even where winters are long and severe. Modern construction methods and such modern materials as Lehigh Early Strength Cement are largely responsible for this trend.

This new dormitory, constructed in Alfred, N. Y. for the New York State Dormitory Authority, illustrates the point. Its reinforced concrete foundations, floors and arches were poured during the winter season.

With Lehigh Early Strength Cement, the concrete reached service strength in less than half the usual time—and winter construction costs were cut all along the line. (On forms and labor alone, for example, the contractor estimated savings of $2000 and $1500 respectively.)

Remember Lehigh Early Strength Cement when planning winter concrete work. On large jobs and small, chances are it will save *you* time and money.

State Architect: Carl Larson, Albany, N. Y.
Plans Architect: Urban, Brayton & Burrows, New York City, N. Y.
Contractor: John W. Rouse Construction Corp., Gouverneur, N. Y.
Ready Mix concrete supplied by: L. C. Whitford Co., Alfred, N. Y.

LEHIGH PORTLAND CEMENT CO.

Allentown, Pa.

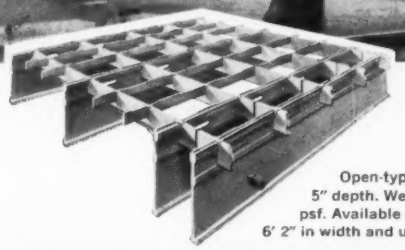
- LEHIGH EARLY STRENGTH CEMENT
- LEHIGH MORTAR CEMENT
- LEHIGH AIR-ENTRAINING CEMENT
- LEHIGH PORTLAND CEMENT

Pouring floor for new Alfred Agricultural and Technical Institute Dormitory.

Lehigh Early Strength Cement helped contractor save on form, winter curing and overhead costs.

Brick walls with concrete block backup for this 300 student dormitory were laid up with Lehigh Mortar Cement.

Reflooring with AMBRIDGE I-BEAM-LOK gives old bridge new lease on life... lifts ban on big trucks



Open-type I-Beam-Lok 5" depth. Weighs 18.8 lbs. psf. Available in units up to 6' 2" in width and up to 49' long.

When the Keokuk Bridge Commission of Keokuk, Iowa, authorized the reflooring of the *repeatedly resurfaced* old timber floor on the bridge across the Mississippi River, their action resulted in far-reaching benefits. For not only did the new open I-Beam-Lok flooring provide a permanent all-weather floor that will *save a considerable amount in upkeep and snow removal,* but also, because it was lighter and stronger than the old floor, it was possible to lift the 10-ton weight limit which had long kept big trucks off this bridge.

Reflooring the 3,152-ft.-long x 18-ft.-wide bridge required approximately 59,000 sq. ft. of 5" TR-type open I-Beam-Lok.

While there is no way to determine accurately the weight of the old floor, built up with layer upon layer of various materials over the years, it seems certain that the weight saved in reflooring was at least three or four times the weight of the I-Beam-Lok itself—18.8 lbs. psf, or 567 tons in all. I-Beam-Lok, being steel, also greatly increased strength, literally giving the old bridge a new lease on life.

For information about the time- and money-saving advantages of this modern lightweight bridge flooring, ask for a copy of our 32-page catalog.

Keokuk Municipal Bridge
Keokuk Bridge Commission, Keokuk, Iowa

Designed by Modjeski and Masters, Harrisburg, Pa.

Contractors: The Whiting-Turner Contracting Company
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USS

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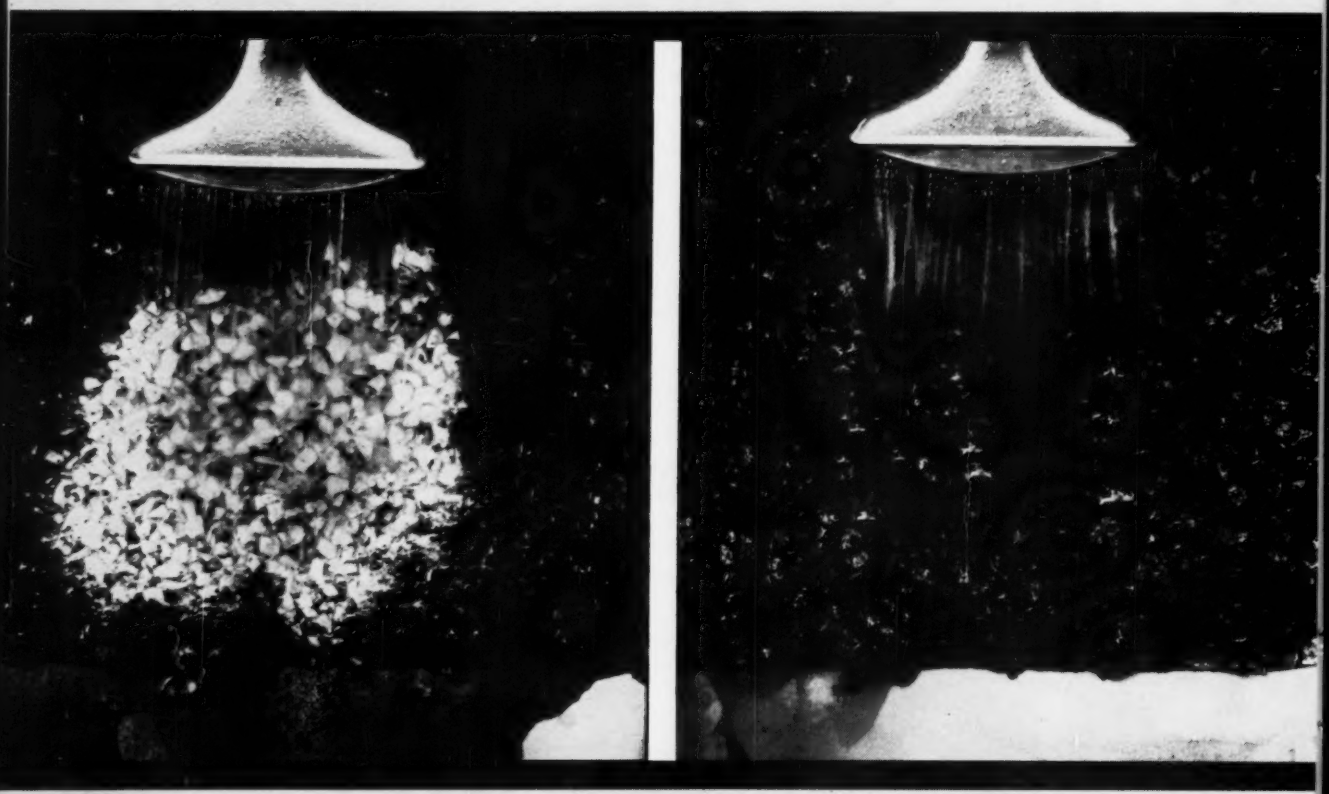
USS AMBRIDGE I-BEAM-LOK BRIDGE FLOORING

UNITED STATES STEEL

Announcing the NEW

CATIONIC BITUMULS

- **Coats "Treacherous" Aggregate**
- **Protects Your Cold-Mix Pavements and Surface Treatments Against Early Rains**



These unretouched photographs taken in our laboratory clearly show the remarkable ability of CATIONIC Bitumuls to coat and hold silica-crystal chips, and to stand up under early rainfall. Here are two samples of cold-mix materials. They are identical with this exception: the sample on the left was mixed with a conventional road emulsion; the sample on the right was mixed with new CATIONIC Bitumuls. No anti-stripping additive was used. Both samples were allowed to cure for 10 minutes; then subjected, as shown, to equally-metered showers of water. Results: the conventional emulsion almost completely washed off, while the CATIONIC binder still coats the silica chips and holds them firmly in position.

YOU NAME YOUR "HARD TO COAT" AGGREGATE—NEW CATIONIC BITUMULS WILL HANDLE IT!

Now—with new CATIONIC Bitumuls—you can treat "hard to coat" aggregate—damp or dry—fast and effectively.

CATIONICS represents a startling new departure in the making of asphalt emulsions. New CATIONIC Bitumuls because of its versatility and "native" affinity for all aggregates enables you to use damp, slick, "hard to coat" gravels and other hydrophilic aggregates.

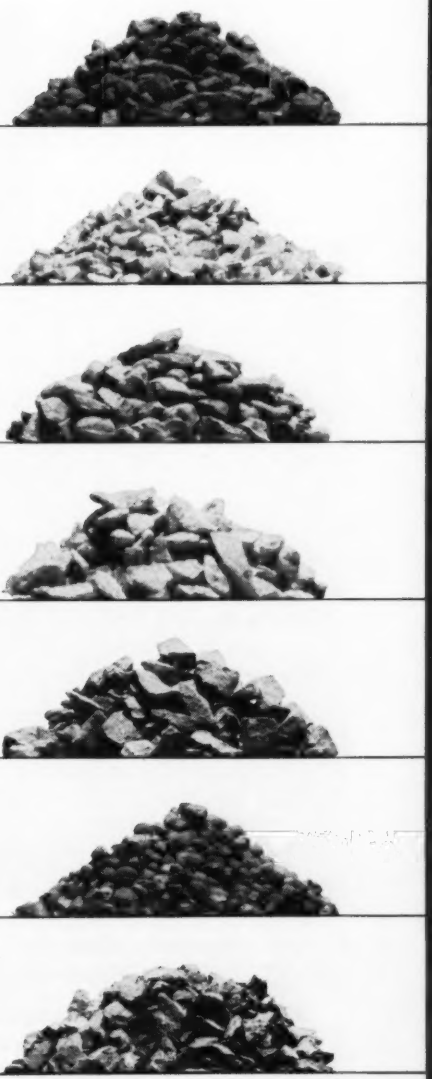
This means you can build—

Better travel plant mix pavements
Better surface treatments

And, you get these better pavements at *lower cost* because with CATIONIC Bitumuls you can use many cheaper aggregates that are unsuitable for use with other binders.

Because the product sets quickly, construction damage resulting from sudden rains is reduced to a minimum. In addition, the fresh paving mixture can be quickly rolled and opened to traffic. All of these benefits mean an extension of the working season into marginal weather conditions that normally would prevent emulsion paving work.

Storage, handling and application are much the same with CATIONIC Bitumuls as with conventional emulsions; however, care must be exercised in the preparation of storage facilities and application equipment. CATIONIC Bitumuls is available from certain of our strategically located plants. Our engineers are ready to discuss projects which you may wish to set up for trials of this new product with specific types of aggregate.



Here are representative samples of the types of aggregate generally regarded as "difficult" by designs engineers. New CATIONIC Bitumuls readily treats all of these. When cold-mixed in a mechanical paver CATIONIC Bitumuls gives thorough stone-coating. There is no stripping in the screw; no drag under the screed. Fast initial set and rapid cure even in deep placements assure early stability; almost immediate rolling.

On Surface Treatment work with slick, hard to coat, (hydrophilic) gravel or stone chips, the new **CATIONIC Bitumuls gives you more in terms of performance** than other binders: rapid set; earlier rolling; faster acceptance of traffic; better cover-stone retention.

Call your nearest American Bitumuls office for information on CATIONIC Bitumuls.

American Bitumuls & Asphalt Company

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Mobile, Ala. San Juan 23, P. R. Tucson, Ariz.
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There's versatility and extra performance in NAYLOR pipe lines—to meet all your requirements.

For dredging operations. For tunnel ventilation. For de-watering and drainage. For hydraulic sluicing. For air to operate pneumatic tools. For water lines. For materials handling.

Light in weight, but extra strong and safe in service, NAYLOR Spiralweld pipe is easy to handle and install. Lines can be made up faster, too—especially when you use the one-piece NAYLOR Wedgelock coupling to speed connections.

It's this all-around dependable and economical performance that has made NAYLOR the stand-by for contractors.

For complete details, write for Bulletin 507.

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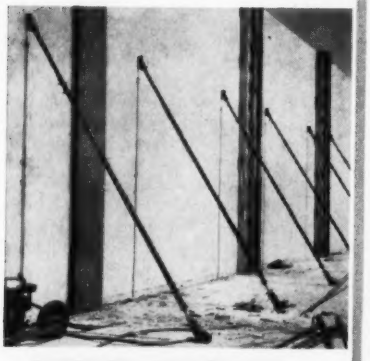
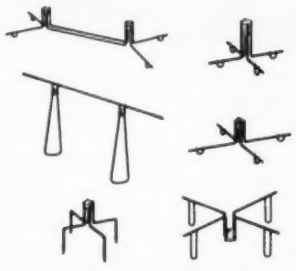
PRECAST PANEL 32 ft. high by 18½ ft. wide has two large window areas.



SUPERIOR ADJUSTABLE BRACES with exclusive pivoting action, permit quick and easy alignment of panels.



SUPERIOR accessories for tilt-up construction are designed for fast and efficient handling of all types of precast panels and structural members.

SUPERIOR "Pick-Up" Inserts, Brace Anchors, and Adjustable Braces have been used and proven on literally thousands of projects, not a few of which were unique in design. With a background of such experience, the recommendation of our engineers as to location and types of Inserts and Anchors is valuable and reliable.

For details request copy of Bulletin TU-3

Superior leads again!

NEW!

STRESS EQUALIZER SYSTEM REDUCES LIFTING STRESS IN HIGH TILT-UP PANELS

Saves

reinforcing steel used in the concrete for the stresses which occur at time of lift.

On any tilt-up job the critical time is, of course, at the point where the load is being transferred from tension to shear, and especially so on panels over 20 ft. high. SUPERIOR Stress Equalizer System was developed to provide the most efficient method of handling these larger tilt-up panels.

Two advantages of this system are: (1) Less concrete reinforcing steel is required for stresses at time of lift; (2) Permits use of simplified crane operation instead of vertical three point lift which requires a rather elaborate system of rigging and which slows down crane operations considerably.

SUPERIOR Stress Equalizer Beams (shown in inset photo above) are now available on a nominal rental basis. Our engineers will make recommendations for the most advantageous use of this system, based on our long experience in the field of tilt-up construction. Write for more details.

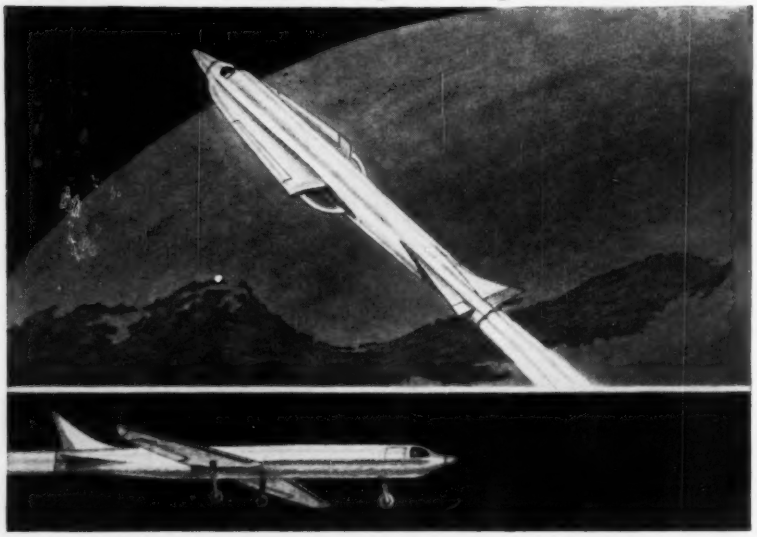
SUPERIOR CONCRETE ACCESSORIES, INC.

9301 King St., Franklin Park, Ill. *(A Suburb of Chicago)*

Pacific Coast Plant
2100 Williams St., San Leandro, Calif.

New York Office
1775 Broadway, N. Y. 19, N. Y.

MARS outstanding design **SERIES**

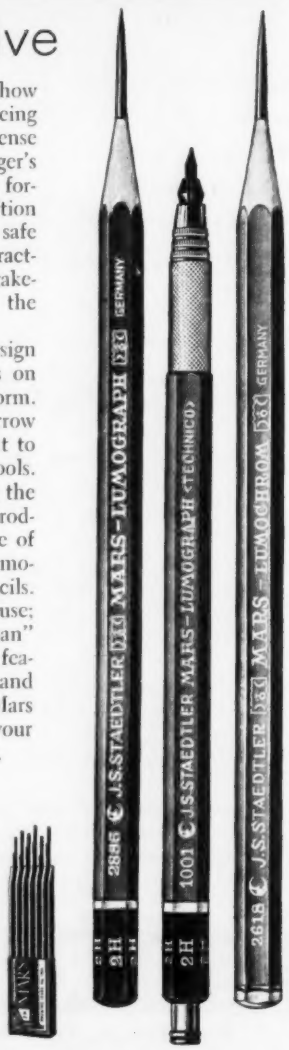


brings 'em back alive

Today's burning problem in space flight is how to ease a rocket safely back to earth, without being consumed by the metal-melting friction of our dense atmosphere. Design Engineer Carl J. Rauschenberger's ingenious suggestion is a pair of wings, locked forward at blast-off, later folded back into flying position (insert) by hydraulic cylinder controls for a slow, safe descent. Mr. Rauschenberger also envisions a retractable glass nose cone, heatproof to withstand the take-off, drawn back to admit air to a jet engine on the return flight.

This outstanding solution to a timely design problem may already exist in working drawings on somebody's drafting board, or even in mock-up form. But whether a project is developed today, tomorrow or the year after next, it will always be important to shape ideas into realities with the best of drafting tools.

In pencils, of course, that means Mars, long the standard of professionals. Some outstanding new products have recently been added to the famous line of Mars-Technico push-button holders and leads, Lumograph pencils, and Tradition-Aquarell painting pencils. These include the Mars Pocket-Technico for field use; the efficient Mars lead sharpener and "Draftsman" pencil sharpener with the adjustable point-length feature; Mars Lumochrom, the color-drafting pencils and leads that make color-coding possible; the new Mars Non-Print pencils and leads that "drop out" your notes and sketches when drawings are reproduced.


2886 J.S.STAEDTLER MARS-LUMOGRAPH GERMANY
1001 J.S.STAEDTLER MARS-LUMOGRAPH GERMANY
2618 J.S.STAEDTLER MARS-LUMOCHROM GERMANY

The 2886 Mars-Lumograph drawing pencil, 19 degrees, EXEXB to 9H. The 1001 Mars-Technico push-button lead holder. 1904 Mars-Lumograph imported leads, 18 degrees, EXB to 9H. Mars-Lumochrom color-drafting pencil, 24 colors.

J.S. STAEDTLER, INC.
HACKENSACK, NEW JERSEY

at all good engineering and drawing material suppliers

Deceased

(Continued from page 102)

Wilbur B. Ream (M. '32), age 62, division engineer of design for the Los Angeles County Flood Control District, Los Angeles, died on November 23. A civil engineering graduate of Bucknell University, Mr. Ream began his work for the Flood Control District in 1935, as office engineer in charge of the design department. Earlier he was engineer in charge of the design department of the Middle Rio Grande Conservancy District, at Alburquerque, N. Mex.

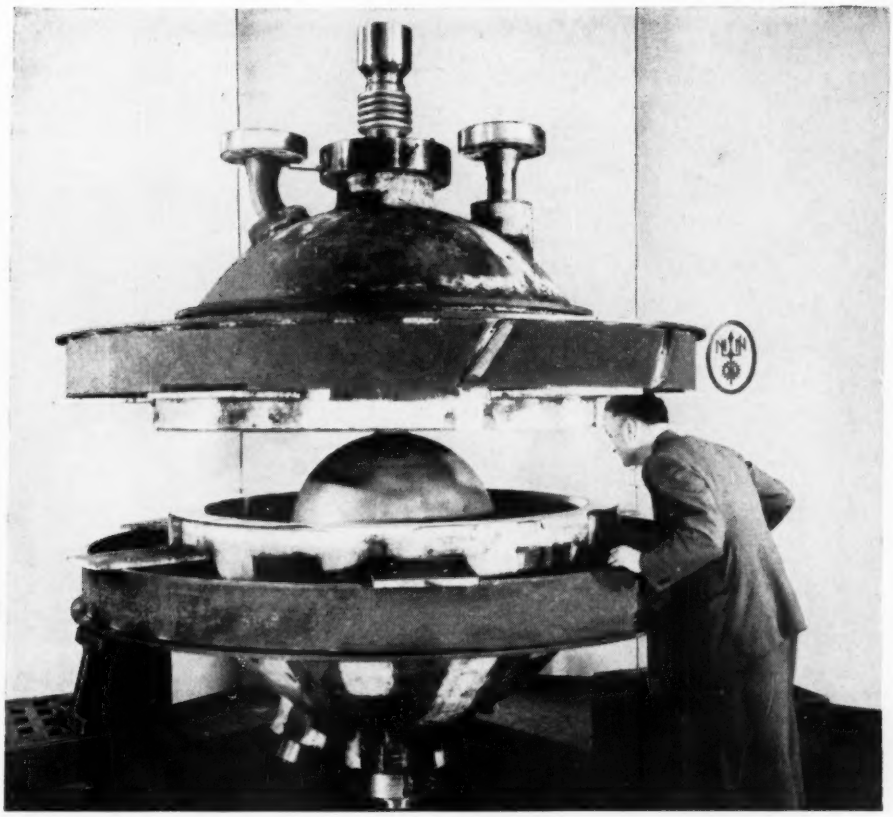
Frank E. Richardson (A.M. '19), age 66, pipeline and refinery engineer with Brown & Root, Inc., died on December 3 in Shreveport, La. Mr. Richardson had served the Texas Eastern Transmission Corporation as project engineer in connection with the conversion of the "Big Inch" and "Little Inch" pipelines from liquid to gas. At one time he was affiliated with the Pan American Companies in Houston as manager of several of their companies. During the war he participated in the design of pipelines in the China-Burma-India theater, and was a member of the Engineering Advisory Committee for P.A.W., which covered all the pipelines in the various theaters of war.

Giovanni Rodio (M. '35), age 69, consulting engineer of Zurich, Switzerland, died there recently. The Italian-born engineer, a specialist in dams and foundations, was engaged in a number of international ventures. Dr. Rodio was owner and consultant of Ing. Giovanni Rodio & Co., of Milan, Italy; Soc. Sondages Etanchements Consolidation Procédés Rodio, Paris, France and Oran, North Africa; S.A. Cimientos y Consolidationes, "Procedimientos Rodio," in Madrid; owner and director of two laboratories for research on soil mechanics in Milan and Paris; and Entreprise de Fondations et Travaux Hydrauliques in Paris. A member of the Italian Council of Research, Dr. Rodio was graduated from Eidgenossische Technische Hochschule in Zurich.

George L. Shattuck (A.M. '47), age 65, retired consultant of G. L. Shattuck & Son, Builders, of Tucson, Ariz., died on November 21. Earlier in his career, Mr. Shattuck served as senior supervising engineer for the RFC, Office of Defense Plants in Philadelphia, Pa.

Robert D. Waterhouse (A.M. '44), age 67, park engineer with the Hawaiian National Park Service, died recently. An engineer with the U.S. National Park Service for many years, Mr. Waterhouse was concerned with the administration, protection, and maintenance of parks, and specialized in highways, bridge work, foundations and topographical engineering.

Alfred Henry Witholder (M. '53), age 53, hydraulic engineer with the United States Section of the International



Assembly of zircaloy-2 core tank and pressure vessel for Homogeneous Reactor Experiment No. 2 (HRE-2). The HRE-2 is a 5,000 KW plant designed for AEC by Union Carbide Nuclear Company. Newport News manufactured the 32" I.D. core vessel from 5/16" zircaloy-2, which involved the development of new welding techniques. The pressure vessel of Type 347 stainless clad steel is 4.4" thick, with an inner diameter of 60". Newport News designed the expansion joint between inner and outer vessels, and also produced the unusual coil-cooled blast shield for the unit.

Zircaloy-2 vessel produced by Newport News...for first two-region breeding homogeneous reactor

Never before had a pressure vessel been constructed from zircaloy-2.

Extremely active chemically, particularly at elevated temperatures, this alloy challenged fabrication. Unshielded, heated zircaloy absorbs atmospheric gases in quantities that render its corrosion and physical properties unsatisfactory. Newport News, however, achieved consistent, satisfactory welds by use of inert gas and novel, plant-developed shielding.

The core tank contains the fuel region where fissioning produces heat. The blanket or reflector region around the tank is confined by a pressure vessel of stainless clad steel.

Newport News, working with its suppliers, developed special fabrication and welding techniques, as well as forge and rolling methods to produce plates and forgings with required corrosion, nuclear and physical properties for both vessels.

Make Newport News your source for fabricated metal structures. See how this company's high integration of skill and facilities can help you. Our illustrated booklet, *"Facilities and Products"*, is yours for the asking. Write for your copy now.

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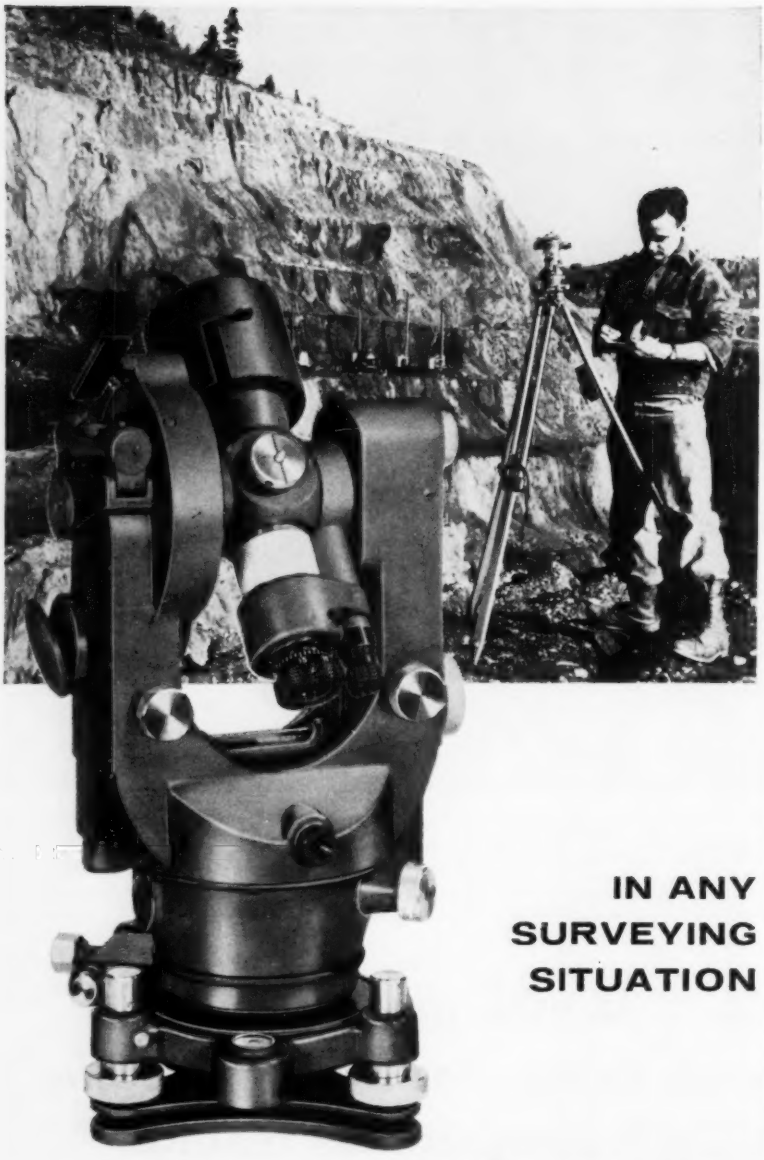
Newport News, Virginia



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Operators in mines, on highways...wherever surveying goes on...welcome the unexcelled speed and precision of the WILD T-1. You will too.

For day or underground use, the WILD T-1 combines fast set-up and error-free readings with rugged simplicity and long, trouble-free life.

Upper and lower motions for setting on zero and for repeating. Built-in optical plummet.

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Boundary and Water Commission, died in El Paso, Tex., on November 30. While with the commission, Mr. Witholder helped design and plan a number of projects along the boundary between the United States and Mexico, and worked on water accounting between the two countries along the international portion of the Rio Grande. Prior to his work with the commission, he served the R. E. McKee Construction Company, and Trost & Trost, Architects.

Glen A. Woodhouse (M. '40), age 66, engineer with the American Water Works Service Company, Inc., of Philadelphia, Pa., died recently. A graduate of the University of Michigan, Mr. Woodhouse served for many years as chief engineer for the American Water Works Construction Company in New York City.

News of Engineers

(Continued from page 22)

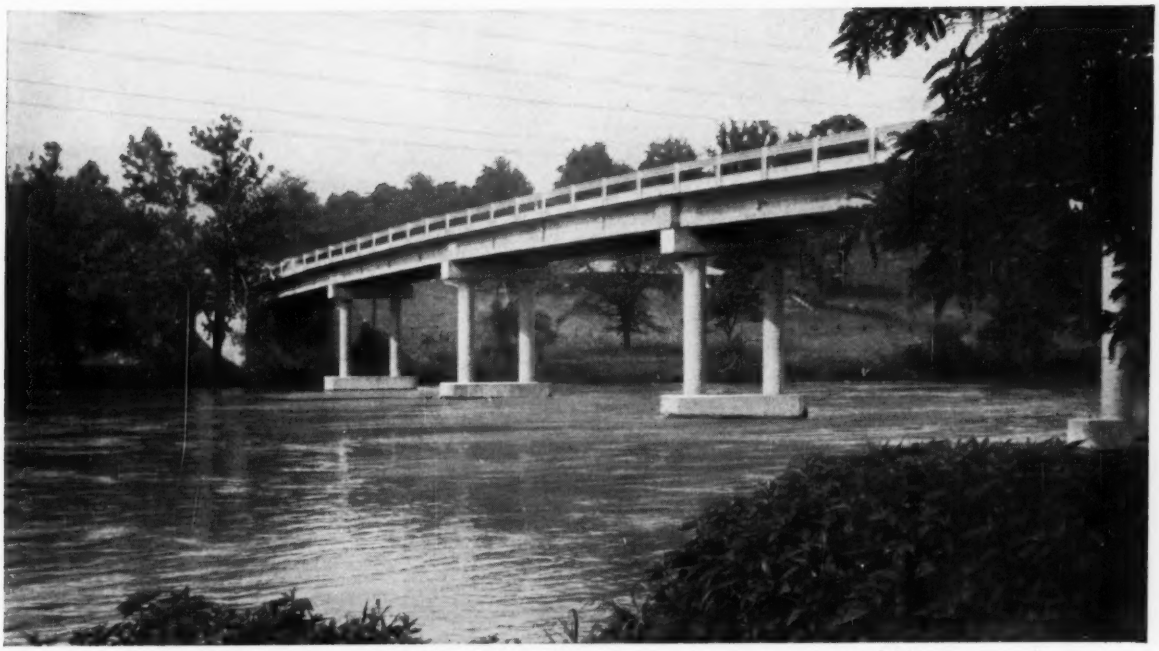
Robert H. Akers, Cincinnati district manager for Armco Drainage & Metal Products, Inc., has been appointed railroad sales manager for the company's Central Division, with headquarters in Cleveland. Mr. Akers will be responsible for all AD&MP railroad sales activity in Ohio, Kentucky and West Virginia. He is currently vice-president of the Cincinnati Section of ASCE.

Robert V. Longcor, West Coast zone engineer for the Stran-Steel Corporation, has been promoted to manager of the company's architectural products sales. Mr. Longcor has served Stran-Steel since 1948.

Arthur I. Flaherty, retired captain in the Civil Engineer Corps, and an officer in the firm of John A. Blume & Associates, Engineers of San Francisco, has been appointed executive secretary of the Board of Registration for Civil and Professional Engineers of the State of California.

Cecil D. Miller, district engineer for the Clay Products Association in Chicago, Ill., has taken a position as district engineer for the Asphalt Institute in Oklahoma City.

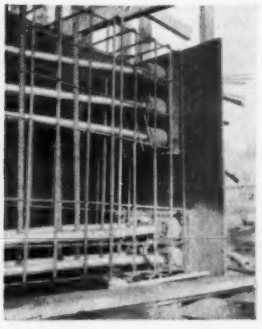
Glen J. Hopkins, regional engineer with the Kansas City Department of Health, Education and Welfare, has been elected chairman of the Missouri Basin Inter-Agency Committee. The Committee, consisting of the governors of the ten states of the Missouri Basin and federal representatives, is to coordinate the multi-million-dollar program of water and land resource development and conservation now underway in the Missouri River Basin.



South Fork Bridge over South Fork of Holston River, Kingsport, Tenn. Owner: Ridgefields, Incorporated. Contractor: Blount Bros. Construction Company, Montgomery, Ala. Consulting Engineer: Mr. H. T. Spoden.

450-Ft. Prestressed Concrete Vehicular Bridge Uses 53 Miles of Roebling Prestressing Wire

Grouting 90-foot girders.



Detail of end reinforcement cage, Freyssinet end anchorages, metal sheath and Roebling wire—90-foot girder.

Spanning the South Fork of the Holston River at Kingsport, Tennessee, this new bridge embodies the Freyssinet cable method of prestressing. These Freyssinet cables—as well as end anchorages, sleeves, grids, and jacking and grouting equipment—were supplied by the Intercontinental Equipment Company, Inc.

Span lengths are 85, 90, 100, 90 and 85 feet, for a total length of 450 feet. Roadway width is 20 feet between curbs. Prestressing units consist of 8 cables of 18 wires each in the 100-foot span, and 7 cables of 18 wires each in the 85- and 90-foot spans. Wire diameter is 0.196 inches.

Roebling is now equipped to deliver cable assemblies composed of a specified number of wires cut to the required length and assembled in flexible metal hose ready for placement in the forms of post-tensioned members.

This facility is, of course, in addition to the standard 7-wire, stress-relieved strand for pre-tensioned bonded prestressed concrete and galvanized strand assemblies for structures where design loads are heavy or require long tensioning elements, and stress-relieved wire for all types of parallel wire cables for post-tensioning.

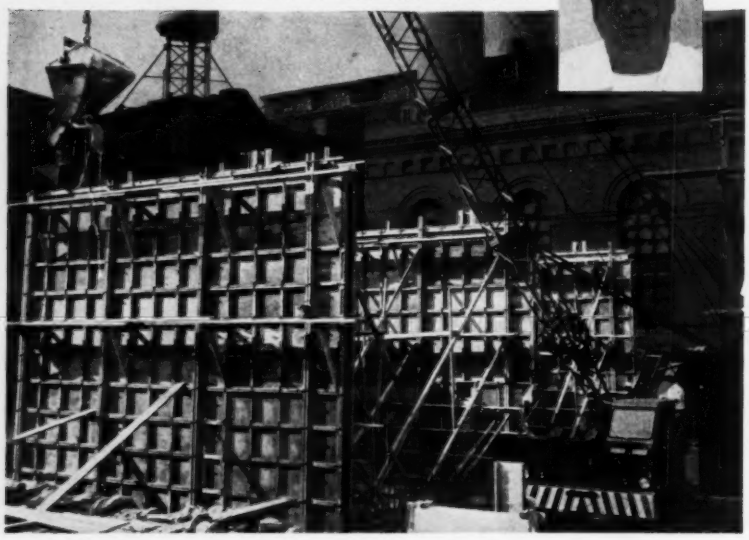
Further, Roebling is always ready to furnish you with information and assistance on *any* phase of this remarkable and widely growing construction method. By writing to Construction Materials Division, John A. Roebling's Sons Corporation, Trenton 2, New Jersey, you can avail yourself of prestressed concrete information on whatever aspect most concerns you.

ROEBLING

Branch Offices in Principal Cities
Subsidiary of The Colorado Fuel and Iron Corporation

"The industry has needed an on-the-job form assembly system like this for a long time."

Lawrence H. Johnston, Form Construction Superintendent; Rosoff Bros., Inc. and Amdor Structures, Inc.



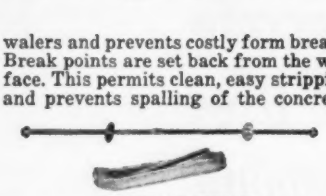
Major Concreting Economies Laid to New Richmond Forming Method

"Everything goes faster—setting the forms, pouring, taking the forms down. No doubt about it, the new Richmond Snap-Ty Form System is the modern way to form and pour."

Mr. Johnston has used this prefabricated panel system on several Rosoff-Amdor projects . . . started as soon as Richmond introduced its new booklet of modular panel forms and made available hardware for putting together prefabricated panels easily—right on the job.

Rosoff-Amdor builds the panels on the job—uses them over and over again. For this job, they stacked them horizontally, used the walers vertically. For walls under 15 feet, they use 3,000-lb. Richmond Snap-Tys; for the high walls, 5,000-lb. Snap-Tys. They pour 26-foot-high walls like these in a single day in one continuous pour.

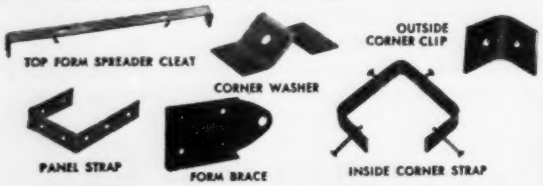
For erection of light foundation wall forms, Richmond Snap-Tys and accessories give you worthwhile savings all along the line. Head washers of Snap-Tys are made of special-strength steel securely held by a clean, well-formed upset at each end to give positive bearing to the Tyholder. This transmits the full strength of the Snap-Ty to the walers and prevents costly form breaks. Break points are set back from the wall face. This permits clean, easy stripping and prevents spalling of the concrete.



SNAP-TY AND TYHOLDER
2 sizes: 3,000 lbs. and 5,000 lbs. safe load

You, too, can benefit by using this fast, easy method for erecting light foundation walls. See for yourself. Send for your copy of the new Richmond Snap-Ty Form Book containing complete diagrams and forming data. It's free for the asking.

Richmond does not make, rent or sell forms. Richmond sells form-tys and accessories only. The free 20-page booklet tells you how to make and assemble your own forms that can be used over and over. Send for it. Ask, too, for your copy of the new Richmond Handbook, which describes the full line of Richmond-engineered tying devices and accessories. Write to: RICHMOND SCREW ANCHOR COMPANY, INC., 816 Liberty Ave., Brooklyn 8, N. Y. or 315 South Fourth St., Saint Joseph, Mo.



Some of the new accessories developed by Richmond for easy on-the-job assembly of prefabricated modular form panels.

New in Education

Dorm Dedicated . . . Lehigh's newest student residence hall has been named McClintic-Marshall House in honor of Howard Hale McClintic and Charles Donnell Marshall, graduates of the class of '88. The two industrialists, heads of the construction company bearing their names, were widely known and esteemed in the field of structural steel.

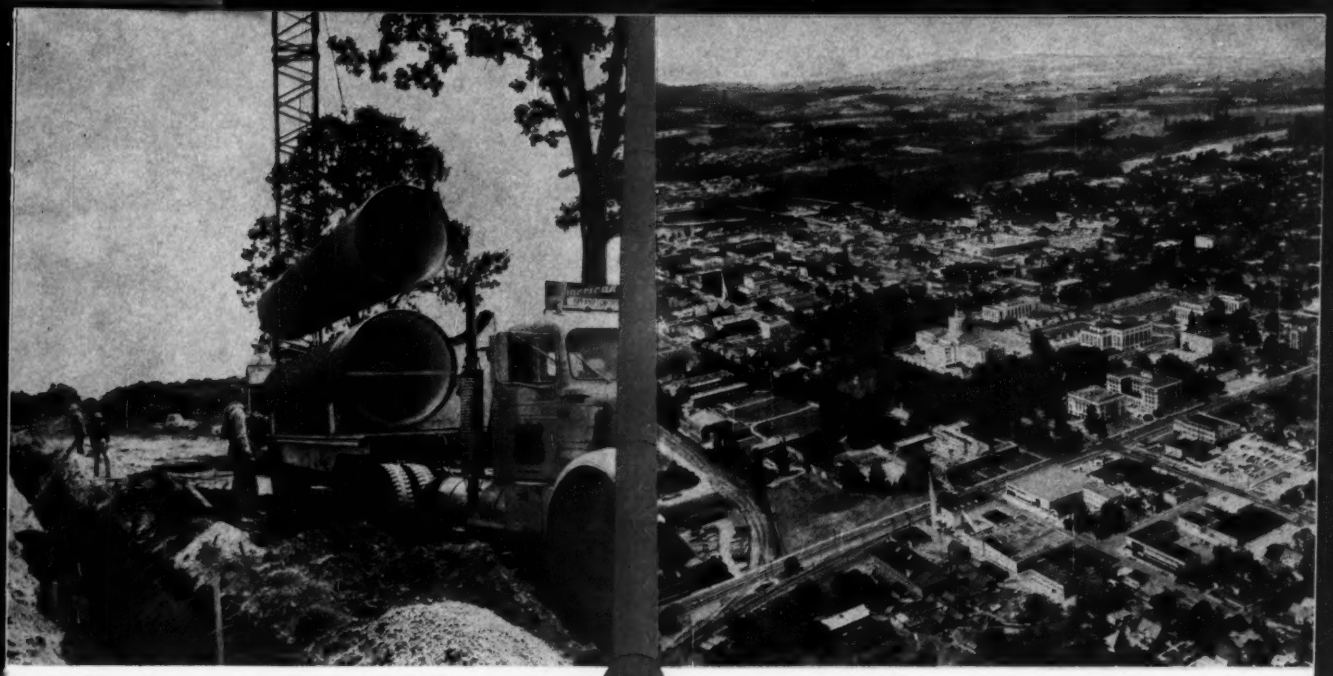
Happy Birthday . . . Cooper Union reports fine progress in its campaign to raise $7,500,000 by the time of its centennial in 1959. Gifts and contributions of more than $4,000,000 have already been received. The funds will be used to build a new engineering school building, enlarge quarters for the Cooper Union Art School, increase endowment for faculty salaries, and make other educational improvements.

For Nuclear Research . . . Two major grants for nuclear research reactors have been announced by the National Science Foundation. A $300,000 grant will go to the State College of Washington at Pullman, and one for $150,000 will be given the University of Virginia. Both schools will build heterogeneous "swimming-pool" type reactors, to carry out experiments in diverse fields.

Lucky Fellows . . . Many groups, vitally aware of the current need for well-equipped engineers and scientists, are now offering fellowships to promising students. Eighteen to twenty Daniel and Florence Guggenheim Jet Propulsion Fellowships, carrying stipends ranging from $1,500 to $2,000, plus tuition, are to be awarded this spring. Information from the Daniel and Florence Guggenheim Foundation, 120 Broadway, N. Y. 5, N. Y. A number of scholarships and fellowships in traffic engineering at the Yale Bureau of Highway Traffic are available for the academic year starting in September 1958. Awards are open to engineering graduates wishing to pursue careers in street and highway planning, design and operations. The closing date for Guggenheim and Yale applications is March 1—so hurry.

Embryo Engineers . . . Highway contractors in Illinois are helping to interest high school students in a highway engineering career. Two $4,000 scholarships are provided each year for students who want to study in this field at the University of Illinois' department of civil engineering. Scholarships are provided by the Associated General Contractors of Illinois, and by two members of the association, S. J. Groves and Sons Company, Springfield, and the McDougal Hartmann Company of Peoria. An anonymous donor gives $1,200 to a civil engineering senior for travel during the summer following graduation.

Healthy Investment . . . The Institute of Industrial Health, University of Cin-



New Salem pipe line to augment present system will add approximately 50 MGD capacity to city water supply system.

a line of growth... for Oregon's capital city

American Concrete Cylinder Pipe is helping Salem, Oregon to grow

A simple but important fact is that no city, however great its potential, can grow beyond the capacity and dependability of its main water supply system.

Recognizing this fact, and envisioning a population in 30 years that will require three times the maximum capacity of present water transmission lines, Salem, the capital city of Oregon, is carrying out a program designed to meet future needs.

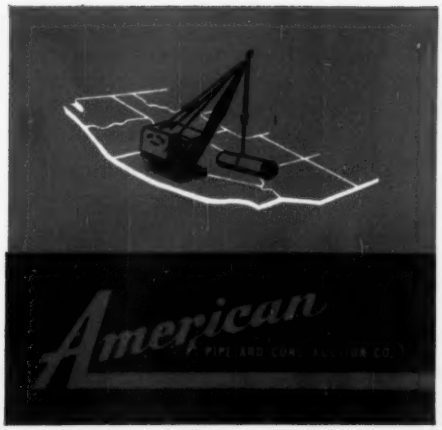
Under the direction of the City's Water Department Manager, John L. Geren, and the technical supervision of Consulting Engineers Clark and Groff of Salem, an 18-mile pipe line of 48" and 54" diameter American Concrete Cylinder Pipe is being installed by Lord Brothers, a general contracting firm of Portland, Oregon. This new line will triple the present capacity of the supply system.

The performance record of this type of reinforced concrete cylinder pipe has been so outstanding throughout the West that Salem can be confident that this water "growth line" will be giving efficient, economical service for many, many years to come.

Strength, permanence, sustained high carrying capacity, and trouble-free service are characteristics of American Concrete Cylinder Pipe which make it the right pipe for this forward looking city.

When planning your future water "growth lines," look to American's quality pipe line products, extensive production facilities and half century of experience.

Ask for complete information concerning the particular class of pipe that will meet your design requirements.



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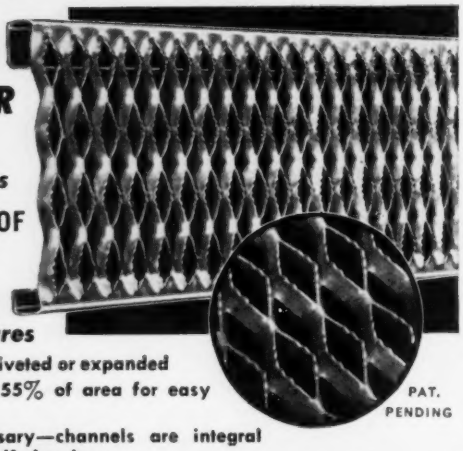
FOR MAXIMUM SAFETY ALL OVER YOUR PLANT



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★ All one piece, not welded, riveted or expanded
★ Open space in excess of 55% of area for easy access of light and air
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Ideal for work platforms, stair and ladder steps, flooring, balconies, catwalks, machinery guards, fire escapes and for original equipment safety treads.

2 **GOLD NUGGET® WELDED *grating*** PAT. PENDING

The QUALITY GRATING for Heavy Duty Applications

★ 3/16" projection weld nugget for greater rigidity and strength
★ Vertical alignment of the main load bar assured
★ All bars are load carrying bars including secondary bars
★ Anti-skid pattern

PROJECTION WELD

Each secondary load bar (A), as projected welded to the primary load bar (B) has a shear strength of 5,000 pounds per weld. There are 28 such projection welds to a square foot of grating. This means that GOLD NUGGET Welded Grating can sustain greater shock loads than other gratings.

For the complete details of these revolutionary new gratings, write for new catalogs today. Distributors in all principal cities. Consult the yellow pages in your phone book under "GRATING".

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cinnati, is offering graduate training for professional personnel other than physicians, in the field of environmental hygiene. A three year course leading to the degree of Doctor of Science in Industrial Health, and a one-year course leading to a master of science degree, are offered.

Summer Scientists . . . The National Bureau of Standards is meeting its increasing need for technical graduates by offering research laboratory jobs to college students during their summer vacations. The long-range recruitment plan offers excellent on-the-job training. Information from the National Bureau of Standards, U. S. Department of Commerce, Washington 25, D. C.

Back to School . . . The Argonne Chapter of the Scientific Research Society of America will sponsor courses for high school teachers who want to review the fundamentals of nuclear energy. Four 2½-week sessions will be offered, beginning June 9, 1958. Inquiries to Dr. Earl W. Phelan, Laboratory Director's Office, Argonne National Laboratory, P.O. Box 299, Lemont, Ill.

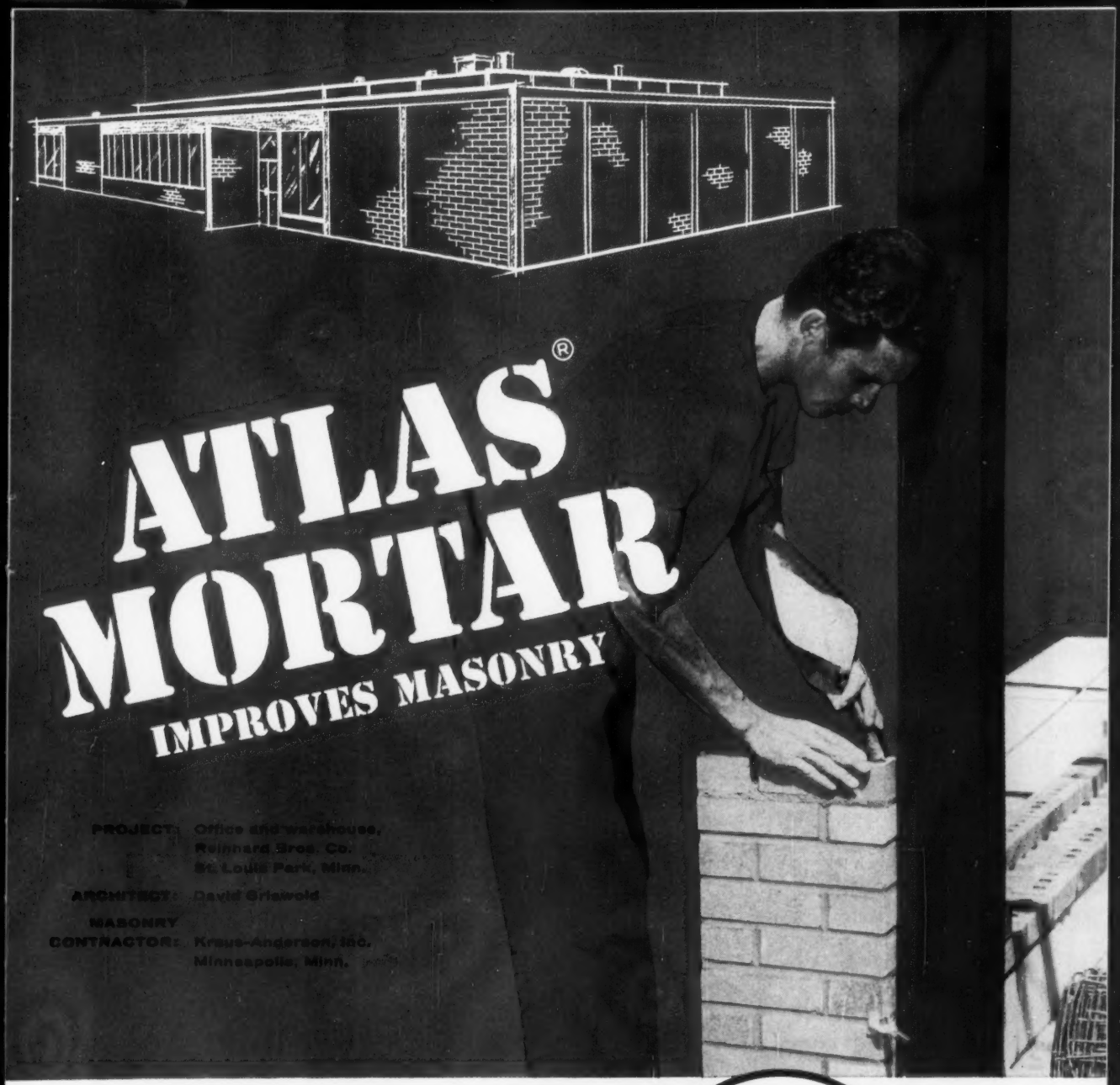
Mechanical Genius . . . A computer laboratory, equipped with a Royal Precision Electronic Computer, has been established at Lehigh University. The new equipment will be used by academic departments of the university for teaching, research projects, and industrial computations.

Top Priority . . . Increasing faculty salaries is the first order of business at the Massachusetts Institute of Technology. The Institute plans to raise at least $5,000,000 to be spent as a "wasting" fund at the rate of one million dollars a year to raise faculty salaries.

Granted . . . 135 universities and colleges have been awarded almost $1,150,000 through Du Pont's program of aid to education. Funds will support the teaching of science and mathematics as well as other subjects. The company will also continue to grant funds for fundamental research and fellowships. The National Science Foundation has awarded a grant of $160,000 to the Midwestern Universities Research Association in Madison, Wis., for the support of a basic research program entitled, "High Energy Accelerator Studies."

Positions Announced

U.S. Navy. Vacancy now exists for an Architectural Engineer (Male), GS-9, at the U.S. Naval Air Station, Quonset Point, R. I. The salary is $6,250 per annum. Candidates should apply to the Industrial Relations Department of the Quonset Point Naval Station.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ARCHITECT: David Griswold
MASONRY CONTRACTOR: Kraus-Anderson, Inc. Minneapolis, Minn.

"... provides a more uniform, workable mortar,"

says R. J. Randolph, Mason Foreman
Kraus-Anderson, Inc.
Minneapolis, Minn.

- To produce serviceable, watertight masonry walls, the mortar mix must be plastic—and have adequate "board life."
- Masons on the job consistently confirm that ATLAS MORTAR cement *does retain* its workability—and gives higher yields.
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Men Available

SENIOR WATER RESOURCES ENGINEER. M. ASCE; B.S. in Civil Engineering; 37. 20 years' U. S. Reclamation Bureau, design and construction on variety of water resource development and civil works; 12 years in Latin America and Asia—supervision of design and engineering for irrigation, navigation, and flood control works; investigations and reports for hydroelectric projects. Present location Far East. Location desired: Latin America or Far East. C-298.

CONSTRUCTION SUPERINTENDENT OR ASSISTANT. M. ASCE; C.E. (P.E.); 58. Over 30 years' in heavy construction of hydro-electric and steam plants; industrial building; sewers; utilities. Supervision of engineering and construction; purchasing; prime and sub-contraction; knowledge of French and Spanish. Location desired: open. C-299.

HYDRAULIC ENGINEER. A.M. ASCE; M.S. in hydraulic engineering; 40. 17 years' with State of Nebraska, War Department, U. S. Army, private consultant, and the State of New Mexico, as civil engineer, hydraulic engineer and college professor. Registered professional engineer in Texas, Colorado, Arizona, and New Mexico. Location desired: Western U. S. or Foreign. C-300.

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Contract documents and plans may be obtained from Auckland Harbour Board, Auckland, New Zealand, or William Coward & Co., 3 St. James's Square, London, S.W.I.

Tenders close at Auckland 30th June, 1958.

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CIVIL ENGINEER. J.M. ASCE; B.C.E.; 26. Electrical sub-station layout, grading and foundation construction—10 months; installation engineer—officer, USAF—programmed for new construction and supervised construction, 2 years; plant engineer (facilities)—10 months. Location desired: Foreign. C-301.

ADMINISTRATIVE ENGINEER. A.M. ASCE; B.S.C.E.; P.E. in N. Y.; 35. Completing studies for M.S. in management engineering. Experience on projects demanding intensive knowledge in mechanical, civil and construction engineering. German fluent, working knowledge of Spanish and French. Location desired: Metropolitan area preferred, overseas considered. C-302.

CIVIL OR STRUCTURAL ENGINEER. J.M. ASCE; B.S.C.E.; 32. Eight years' experience in structural, highway, and municipal design and surveying. Location desired: Southwestern U. S. or South America. C-303.

STRUCTURAL DESIGNER. A.M. ASCE; C.E.; 64. Industrial, mill and multi-story office buildings, housing, incinerators, hangars, power plants, arches, bridges, flood control, drainage, waterworks; 33 years' local experience. Location desired: New York City or Northern New Jersey. C-304.

EXECUTIVE. ADMINISTRATION CIVIL ENGINEER, A.M. ASCE; 52. 29 years' U. S., international background; diversified industrial companies, consulting engineers, including product, operations-maintenance, new construction, plants, facilities. Administration areas—efficiency, cost engineering, control, budgets, contracts, liaison, negotiations. Engineer—civil field, office practice, fringe experience, mining, metallurgical, others. Periods specialization water resources, hydro-electric, hydraulics. Location desired: California, Oregon, New Mexico, Utah and Arizona. C-305-836—San Francisco.

STRUCTURAL ENGINEER. A.M. ASCE; B.C.E.; 34. P.E. in N. Y. Structural engineer, 10 years' experience both foreign and domestic in military construction, power plant and petroleum industrial design work. Desire responsible position in design or specifications. Location desired: New York or Overseas. C-306.

PLANT ENGINEER-PROCESS INDUSTRY. J.M. ASCE; B.S.C.E.; 28. 7 years' experience in design, construction and operation of plants for processing bauxite. Some mining and general civil engineering experience. Registered C.E. Presently located in Louisiana. Very adaptable as to location. A-181.

CHIEF ENGINEER. PROJECT MANAGER. A.M. ASCE; C.E.; 45. Pipelines, waterworks, bridge highways, 1 year chief engineer for dredging company, 4 years' chief engineer, directed preparation of plans, estimates and specifications for waterworks, pipelines, pumps, plants and flood control structures, 5 years' senior civil engineer, head of hydraulic design department, 5 years' design reinforced concrete and structural highway and R.R. bridges. Presently located in Hawaii. A-196.

SALES ENGINEER. J.M. ASCE; B.S.C.E. Development or Production-Metal working, Petroleum, Chemical, Power; over 1 year civil engineer for heavy construction firm. Responsible for preparation of bids, proposals and contracts; field engineering; estimating; construction supervision; also assistant resident engineer of bridge construction for highway construction. Presently located in Illinois. Location desired: Midwest or West. A-693.

OFFICE MANAGER-COST ENGINEER for Contractor or Consultant, M. ASCE; B.S.C.E.; 70. Good mental and physical ability and civil engineering experience so varied that: you name it and he has done it. Will consider any reasonable offer in order to keep active. Presently located in San Francisco. Location desired: California. A-685.

Positions Available

INSTRUCTORS to teach college level courses preparing students for the building construction industry. College degree preferred but satisfactory experience will be considered. Location: South. W-5611.

TEACHING PERSONNEL. (*a*) Instructor in civil engineering; M.S. not required. (*b*) Assistant or Associate Professor with interest in sanitary engineering; M.S. or Ph.D. required. Positions available September 1958. Location: West. W-5623.

PLANNING DIRECTOR, graduate civil, with executive ability, to direct a large county planning project. Permanent. Salary, $10,500 a year and up. Location: New York suburban area. W-5626.

PROJECT MANAGER, graduate civil, 40-55, with from 10 to 15 years' supervisory experience on highway and highway bridge construction. Will head division dealing with foreign road contracts. Headquarters: New York, N. Y., with considerable foreign travel. Salary commensurate with past experience. W-5636.

ASSOCIATE PROFESSOR for Department of Civil Engineering, to teach surveying and photogrammetry. Will also be in charge of surveying instruction and responsible for development of laboratory facilities in photogrammetry and aerial surveying. Salary, on a twelve-month basis, $7,500 a year. Location: South. W-5654.

CONSTRUCTION ENGINEERS with at least 10 years' multi-story fireproof apartment and commercial building experience. (*a*) Project Engineer, 35-55, with estimating, planning, subcontracting, negotiating and cost experience. Salary, $9,100-$10,400 a year. (*b*) Chief Engineer, civil graduate, preferably P.E. license, 50-60, with at least 15 years' experience. Salary, $15,000-$20,000 a year. (*c*) Senior Estimator to prepare figures from preliminary plans and sketches. Salary, $7,800-$10,400 a year. (*c*) Construction Superintendent to take charge of construction of apartments and commercial buildings. Salary, $11,700-$13,000 a year. (*c*) Project Coordinator to supervise electrical and mechanical construction and installations. Salary, $13,000-$15,600 a year. Location: New York area. W-5668.

PLANNING ENGINEER, under 35, preferably civil graduate, with experience in highway and urban traffic planning. Some experience in design in the civil engineering field desirable. Salary open. Location: South. W-5683.

SANITARY ENGINEER, graduate civil, to survey, design and lay out water distribution systems, including elevated storage tanks for rural communities in Libya. Six-month initial assignment although contract may develop into several years' work. Salary, $12,000 a year plus all travel expenses. F-5696.

BOROUGH ENGINEER, civil or mechanical engineer, with a knowledge of surveying, water systems, sewerage disposal, plumbing, building construction, heating, road work and allied work. Will consider a young man with little experience or an older man. Location: northern New Jersey. W-5698.

INSTRUCTOR, M.S., for civil engineering department, to teach fluid mechanics, sanitary engineering and surveying. Salary, to $6,500 for 9 months. Position available September 1958. Location: Ohio. W-5711.

ASSISTANT DIRECTOR, young, civil engineering background, with a year or more of experience in planning or training; or experience and interest in traffic problems. Salary, $6,000 a year. Location: central New Jersey. W-5715.

CIVIL ENGINEER, graduate, with railroad experience on terminal type facilities, for both field and office work on studies, reports and design

of both railroad and industrial facilities and grade separation work. Salary, $7,800-$9,000 a year, plus fringe benefits. Location: deep South. W-5759.

SENIOR STRUCTURAL ENGINEER with considerable design, specification and field experience covering warehouses, hangars and general military construction. Must be U. S. citizen. Salary, $12,000 a year plus extras. Location: Far East. F-5761.

WATER WORKS ENGINEER, civil graduate, for design and layout of water supply systems, filtration plants and pumping stations. Salary, $6,000 a year. Location: New York, N. Y. W-5769.

ENGINEER with municipal engineering experience. Must be executive, administrator type with good engineering background, who is well acquainted with civil engineering, sewerage, roads, etc. Will be in charge of building departments, sanitation and road work. Salary open. Location: New Jersey. W-5771.

TEACHING PERSONNEL in the fields of surveying, hydraulics, highway engineering and structures, principally the first two. Positions available in February or September 1958. Location: Midwest. W-5774.

CIVIL ENGINEER for technical sales. Training will be given in concrete technology and sales. Excellent opportunity for future growth with national concern. Salary plus expenses and commissions. Must be willing to relocate anywhere in the U. S. W-5775.

ASSISTANT TO ESTIMATING AND PROJECT MANAGERS, to 33, degree in civil engineering or architecture; advanced degree, especially in business administration, preferred. Work involves quantity take-offs and coordination of sub-contractor estimates in connection with the preparation of proposals for clients; the award of sub-contracts, supervision of sub-contractors and own field forces and liaison with clients. Salary open. Location: New York, N. Y. W-5776.

ASSISTANT OR ASSOCIATE PROFESSOR, civil graduate with at least an M.S. degree, for teaching undergraduate courses in structures and graduate courses in advanced reinforced concrete and thin shell design. Records of practical experience and publications will be considered. Salaries, minimum: Assistant Professor, $5,500 up; Associate Professor, $6,000 up for 9 months. Location: Illinois. C-6638.

RECENT BOOKS

(added to the Engineering Societies Library)

ACI Manual of Concrete Inspection

Fourth Edition, 1957.

This manual describes methods of inspecting concrete construction generally accepted as good practice, supplements the specifications of a job and provides guidance in areas not covered by specifications. Areas included are the inspector, proportioning of mixes, inspection and testing of materials, inspection before, during, and after concreting, testing of concrete, and records and reports. Special features are a list of standard specifications and test methods, and a checklist of inspection. It is intended to be useful not only to inspectors but to engineers and contractors as well. The American Concrete Institute, P.O. Box 4754, Redford Station, Detroit 19, Michigan. 240pp., $3.50.

Atomic Power, An Appraisal

The contents of this volume are based on an informal panel discussion held by the International Bank for Reconstruction and Development. The participants, all leading world figures in atomic energy development, present a picture of the present and future potentialities of nuclear power in economic terms and its probable impact upon individuals and nations. Pergamon Press, 122 East 55th Street, New York 22, N Y., 1957. 151pp., $3.50.

Deutscher Ausschuss Fur Stahlbeton

Heft 122: Gestaltfestigkeit von Betonkörpern; Warmzerreissversuche mit Spannstahlen; Konzentrierte Lasteintragung in Beton.

This is a compilation of three reports, as follows: tests on the influence of the shape of a concrete body on its compressive strength; tensile tests at elevated temperatures on tension cables, and evaluation of fire tests on prestressed and non-prestressed reinforced-concrete structural members; tests on the transfer of high local compression in reinforced concrete. Full results are given in tabular or graphic form in each case. Wilhelm Ernst & Sohn, Berlin, Germany, 1957. 52pp., DM 14.

Education for Planning: City, State, and Regional

With rapid urbanization the spread of industry, and pressures on water, land, and energy resources in various parts of the country there is an increased need for formal planning activities. The author, Harvey S. Perloff, considers the appropriate bases for the education of city and regional planners and attempts tentative conclusions. Three essays deal with the problem and review University of Chicago experiments in these areas. The Johns Hopkins Press, Homewood, Baltimore 18, Md., 1957. 189pp., $3.50.

Fundamentals of Hydro- and Aeromechanics
Applied Hydro- and Aeromechanics

These are unabridged and unaltered reproductions of two books by O. G. Tietjens, based on lectures of L. Prandtl, first published as Engineering Societies Monographs in 1934. They have been out-of-print for several years. Dover Publications, Inc., 1780 Broadway, New York 19, N. Y., 1957. 270pp., 311pp., $1.85 each.

A Guide To Graduate Study

This volume, edited by Frederic W. Ness, is a survey of facilities including schools of engineering, available to the person interested in securing a doctorate. Preliminary material touches on various aspects of graduate study—choice of vocation, selection of graduate school and costs. The main portion of the volume consists of a directory of graduate schools and pertinent information on admission requirements, fees, tests and averages, financial assistance, fields of study, and faculty and enrollment. The subject index includes entries under all branches of engineering. Association of American Colleges, Wash., D. C. 1957; distributed by the American Council on Education, 1785 Massachusetts Ave., N.W., Wash. 6, D.C. 335pp., $5.00.

Handbook For Welding Design

Volume I.

This handbook, edited by C. R. Harman, is devoted to the design of products fabricated in mild or low alloy steels by the metal-arc welding process. Wherever possible information is based on the relevant British standards or other recognized equivalent. The first volume is intended to provide the designer of a welded assembly with the data necessary to design a product both economical and of standard quality. Included are choice of materials, properties of sections, classification of electrodes, types of welded joints, design of welds, typical assemblies, and welding costs. Published for the Institute of Welding by Sir Isaac Pitman & Sons, Ltd., London, England, 1956. 305pp., 45s.

Handbuch Der Werkstoffprufung

Volume III, Die Prüfung nichtmetallischer Baustoffe, edited by Otto Graf. Second Edition.

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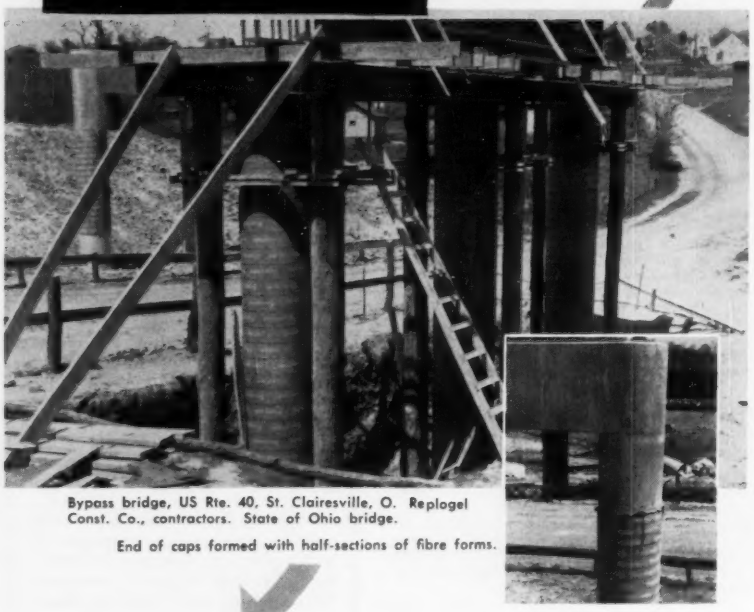

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Erich Siebel, is on materials testing deals with nonmetallic construction materials. It provides a thorough treatment of the methods and apparatus for determining all important properties of wood, building stone, mortars, cement and concrete, precast structural elements, glass, paper and paperboard, bituminous materials, paints, adhesives, and laminated structural elements. Chapters are also devoted to heat and sound insulating properties, fire resistance, foundations and soils. Springer Verlag, Berlin, Germany, 1957, 1026pp., DM 138.00.

A History of Technology

Volume 3—From the Renaissance to the Industrial Revolution, c 1500-c 1750.

The third of a five-volume history edited by Charles Singer and others, will cover the subject from the Old Stone Age to the later nineteenth century. The present volume gives due attention to the pendulum clock, inquires into the properties of metals, and to improvements in scientific instruments—developments of significance for future centuries—as well as to the great wooden ships, huge machines for raising water, and massive stone buildings that were the culmination of long technological traditions. Like others in the series the volume is superbly printed and illustrated. Oxford University Press, 114 Fifth Avenue, New York 11, N. Y., 1957, 766pp., $26.90.

International Conference on Soil Mechanics and Foundation Engineering: Proceedings of the Fourth Conference, London 1957

These volumes contain papers prepared for the conference, grouped by subjects as follows: soil properties and their measurement; techniques of field measurement and sampling; foundations of structures; piling and piled foundations; roads, runways, and railroad tracks; earth pressure on structures and tunnels; earth dams, slopes, and open excavations. Together, the more than 175 papers included constitute a comprehensive summary of advanced work on practically all phases of soil mechanics and foundation engineering. A third volume containing a record of the proceedings and the discussion will be published later. Butterworths Scientific Publications, London, England, Volume 1 and 2, 466pp. each, $73.50 each.

Irrigation and Hydraulic Design

Volume 2: Irrigation Works.

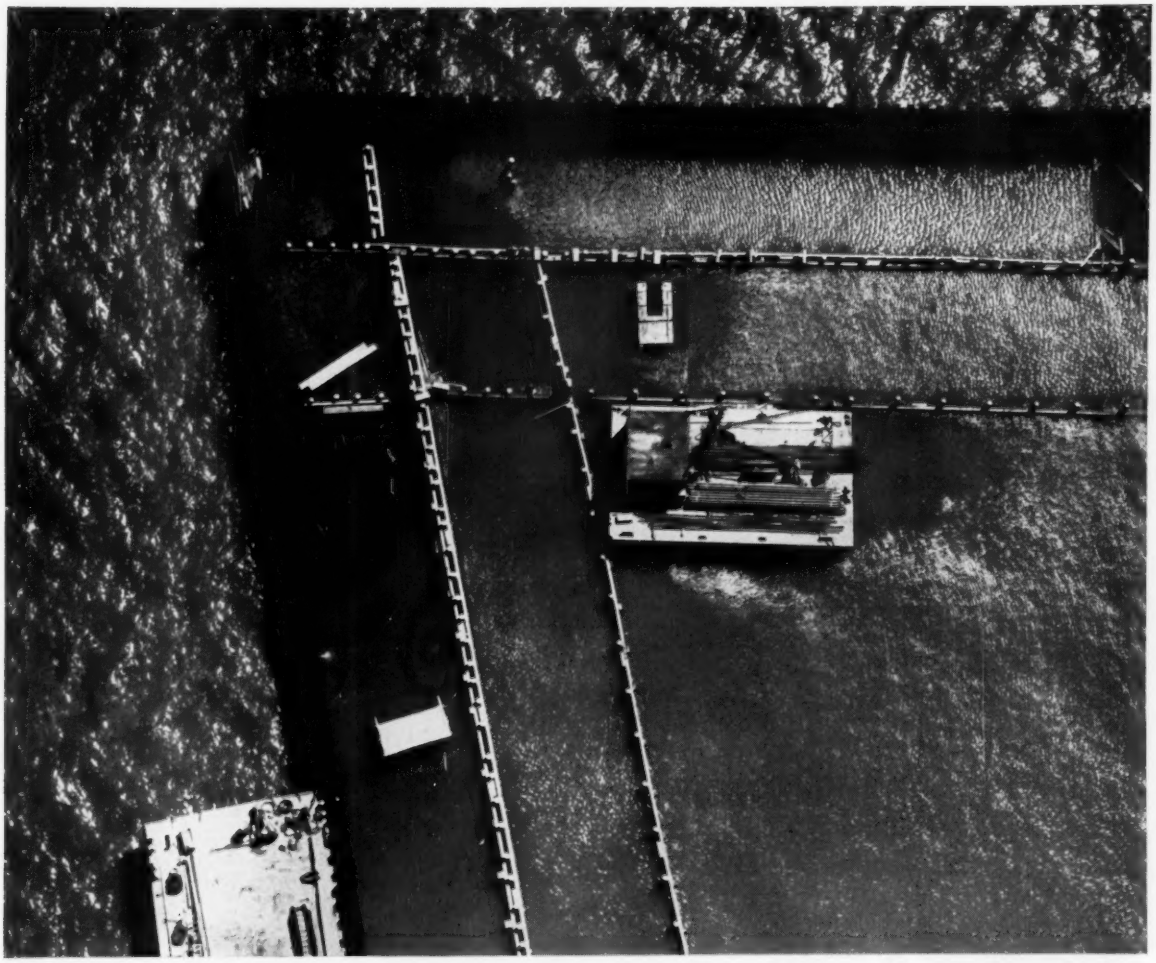
This volume by Serge Leliavsky, is intended to provide the irrigation and hydraulic designer with all the data, figures, tables, etc. which he may need in his work. As compared with the general fundamentals presented in the first volume, this one is devoted to specific design methods and theory for irrigation works, including regulators of all types, syphons, weirs and other canal structures, planning and designing a perennial irrigation canal scheme, canal bridges, aqueducts, gates and other aspects of hydraulic design frequent in irrigation practice. The Macmillan Co., 60 Fifth Avenue, New York 11, N. Y., 1957, 864pp., $60.00.

Materials Handling Equipment

Virtually an encyclopedia of materials handling equipment, this volume shows how the various machines function and what they can do. Six of the seven sections are devoted to principal types of machinery—transporting, elevating, conveying, transferring, self-loading, and bulk-handling. A seventh section is devoted to accessories. Over 2000 line drawings illustrate the internal parts of the machines discussed by the author, D. Oliphant Haynes, Chilton Company, Chestnut and 56th Streets, Philadelphia 39, Pa., 1957, 636pp., $17.50.

The Measurement of Soil Properties in the Triaxial Test

In the successful application of soil mechanics to civil engineering problems, laboratory tests play an important role. This manual, by Alan W. Bishop and D. J. Henkel,



This interesting air view of the new passenger and automobile pier in Milwaukee's outer harbor shows Bethlehem steel sheet piling driven to hard strata in about 25-ft of water. Contractor was Great Lakes Dredge and Dock Co., Chicago.

Deep-Water Piers for Milwaukee

The Board of Harbor Commissioners of the City of Milwaukee is preparing for the 1959 opening of the St. Lawrence Seaway by expanding port facilities and services. Outer harbor channels will be deepened to the Seaway's 27-ft draft, a number of piers and cargo terminals are either planned or under construction, and improvements in railway and truck facilities directly to the outer harbor are being made.

Two of these important projects are illustrated here. First is a new outer-harbor passenger and automobile pier where Bethlehem steel sheet piling was driven to hard strata in about 25-ft of water. About 2800 ft south is the second project, the construction of bulkheads enclosing a reclaimed 20-acre tract. The latter project will provide 1900 ft of deep-draft berthing space and the reclaimed land eventually will be the site of both terminal and industrial facilities. Here, too, Bethlehem steel sheet piling was used to form the permanent walls of the bulkhead.

General view of two new Milwaukee outer harbor construction projects. In foreground is passenger and automobile pier under construction. Rear, the sheet piling bulkhead enclosing about 20 acres of reclaimed land. Contractor for this job: Edward E. Gillen Co., Milwaukee.

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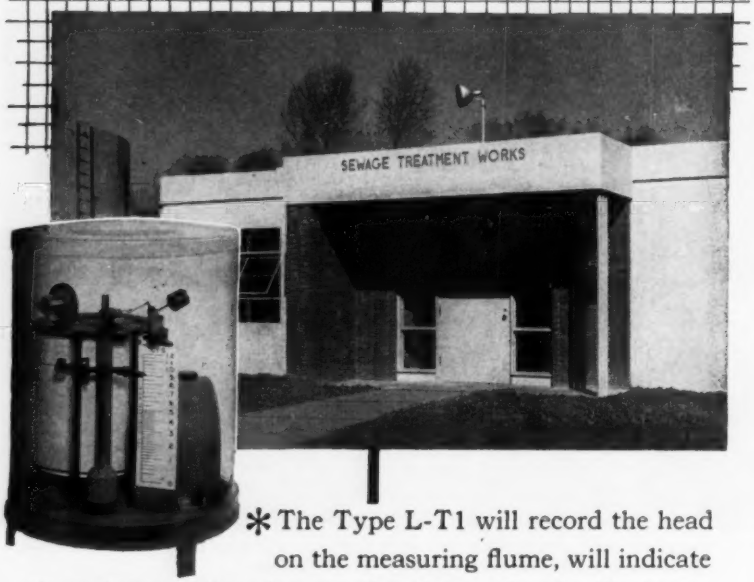

* The Type L-T1 will record the head on the measuring flume, will indicate the volume of flow for any time interval and will give an instantaneous reading of the rate of flow. The head record, made on convenient rectangular coordinates, is basic information for permanent record from which plant operators and State Sanitary Engineers can check flows and volumes. The volume reading from the totalizer dials and the rate of flow indicator are essential for intelligent operation. Readings can be made in any desired volume and flow units.

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is restricted to one of the most important of these test methods, and describes the principal features of the apparatus, the standard tests performed, and a variety of special tests. It also discusses the role of soil testing in civil engineering work and includes a bibliography. St. Martin's Press, Inc., 103 Park Avenue, New York 17, N. Y., 1957. 190pp., $10.00.

Safety Aspects of Nuclear Reactors

Composed of key papers from the Geneva Conference on the Peaceful Uses of Atomic Energy, the material has been carefully selected and edited by C. Rogers McCullough. They are grouped under the following headings: normal reactor and chemical plant operations; development of radiation safety criteria; reactor accidents and their consequences; super-critical reactor experience. Since little has been available on the subject, this is a useful contribution in an area that will assume more importance as the power reactor program is developed. D. Van Nostrand Company, Inc., 120 Alexander Street, Princeton, N. J., 1957. 237pp., $8.50.

Soviet Education for Science and Technology

Alexander G. Korol has written a general outline of the educational system of the Soviet Union from elementary through graduate school. A considerable portion of the book is devoted to the technicum and other specialized schools which train students for work at the subprofessional level. There is also an extensive study of Soviet undergraduate higher education, with curricula in physics and a typical major in mechanical engineering shown in detail. The author's conclusions are at variance with some of the accepted generalizations concerning Soviet education. John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y., 1957. 513pp., $8.50.

Water Waves

J. J. Stoker's book is a study of the mathematical theory of wave motion in liquids with a free surface and subjected to gravitational and other forces, together with applications to a wide variety of concrete physical problems. A large part of the book deals with problems the solutions of which have been found during and since World War II. Aspects investigated are the derivation of the basic hydrodynamic theory for non-viscous incompressible fluids, the approximate theory which results when the amplitude of the wave motions considered is small, problems involving waves in shallow water, and problems solved in terms of the exact theory. Interscience Publishers, Inc., 250 Fifth Avenue, New York 1, N. Y., 1957. 567pp., $12.00.

Welding Handbook

Fourth Edition, Section One

This standard reference work is now to appear in five volumes, of which this is the first. It contains the fundamentals of welding: terms; general engineering tables; welding metallurgy; properties of welded joints and treatment of weldments; cost estimation; inspection and testing methods; statistical control of weld quality; safety practices. An extensive and detailed index provides quick reference to the contained information. American Welding Society, 29 West 39th Street, New York 18, N. Y., 1957. Various pagings. $9.00.

Library Services

Engineering Societies Library books may be borrowed by mail by ASCE members for a small handling charge. The Library also prepares bibliographies, maintains search and translation services, and can supply photoprint or microfilm copies of any items in its collections. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th Street, New York 18, N.Y.

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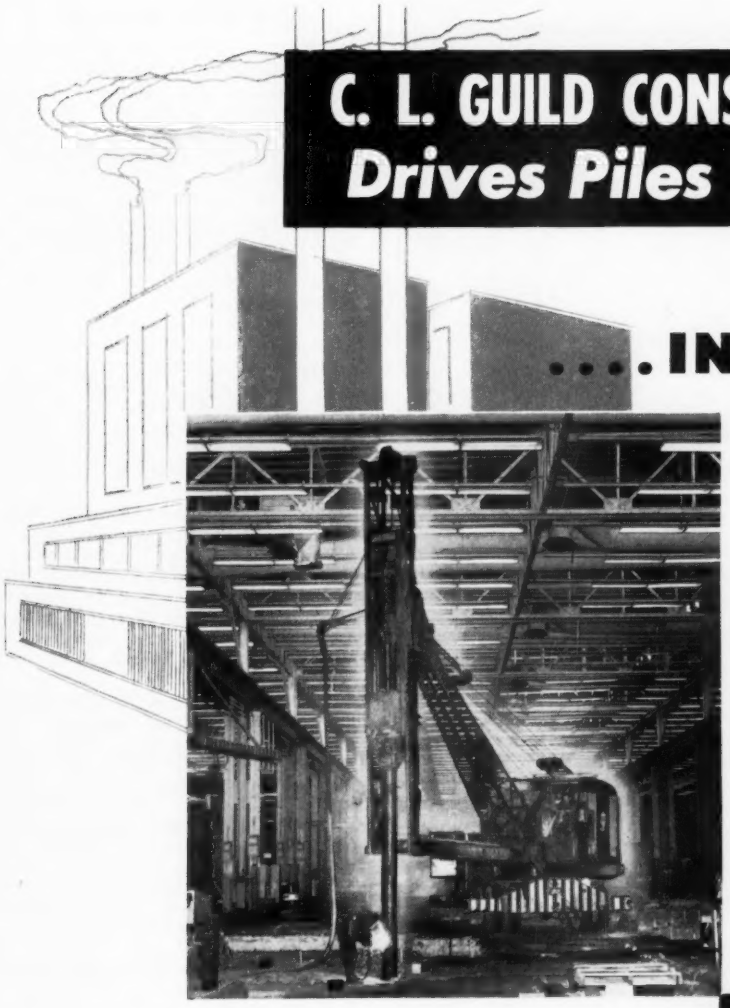
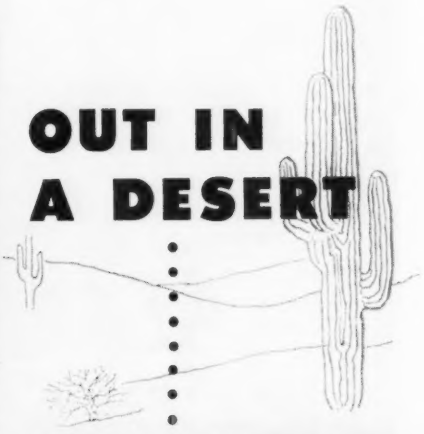


. . . . INSIDE A BUILDING

OUT IN A DESERT



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No matter where the job — deep in the work-restricting vaults of an industrial building or out in the vast open desert — from shore to shore anywhere in the U. S. A., no matter what the time of year, the climate, or the soil condition, fast-acting C. L. Guild Construction Co., Inc. has a record for intelligently confronting and successfully completing any piling job. Specialists in the use of Cobi Piles, experts in driving every type of pile on any type of job. Ask for factual data.

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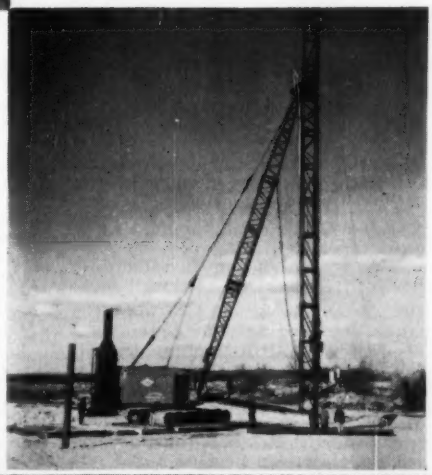

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Illustrated above, on location, is a truck-mounted Sprague & Henwood Model 30 Core Drill Machine. On this foundation project this machine is recovering both good samples and good cores. The soil samples have already been recovered from this boring and now the machine is being used to core rock. Because of the versatility and economy of this machine it is becoming a favorite of many contractors and other users throughout America.

The proper machine alone will not give you the good soil samples and rock cores you want. You need just the right samplers, accessory equipment and coring bits. If you need a sampler to determine only the general classification of the sub-surface soils or a sampler to secure samples for testing in a soils laboratory, Sprague & Henwood has it. There is a complete line of accessory equipment and the best in "Oriented" Diamond Bits awaiting you. One call . . . to SPRAGUE & HENWOOD, Inc., and your drilling equipment needs can be met.

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Non—ASCE Meetings

American Concrete Institute. Annual Convention at the Morrison Hotel, Chicago, Ill., February 24-27. For information write the Institute, P.O. Box 4754, Redford Station, Detroit 19, Mich.

American Concrete Pipe Association. Fiftieth Anniversary Convention at the Roosevelt Hotel, New Orleans, La., week of March 9. Information from the Association, 228 North La Salle Street, Chicago 1, Ill.

American Congress on Surveying and Mapping and American Society of Photogrammetry. 1958 ACSM-ASP Consecutive Meetings and Co-Exhibit, at the Shoreham Hotel, Wash., D. C., March 23-29. Write ACSM-ASP, 1515 Massachusetts Avenue N.W., Wash. 5, D. C.

American Institute of Chemical Engineers. Fourth Nuclear Engineering and Science Conference at the Chicago International Amphitheatre, Chicago, Ill., March 17-21. For information contact Joel Henry, Congress Manager, American Institute of Chemical Engineers, 25 West 45 Street, New York 36, N. Y.

American Institute of Mining, Metallurgical, and Petroleum Engineers. Annual Meeting at the Hotels Statler and Sheraton-McAlpin, New York City, N. Y., February 16-20.

Georgia Institute of Technology. Seventh Georgia Highway Conference at Georgia Tech, Atlanta, Ga., February 24-25. Contact Richard Wiegand, Director, Short Courses & Conferences, Georgia Institute of Technology.

Illinois Institute of Technology. Twentieth Anniversary Meeting of the American Power Conference at the Hotel Sherman, March 26-28. Information from Dr. E. R. Whitehead, Illinois Institute of Technology, Chicago 16, Ill.

National Association of Corrosion Engineers. Fourteenth Annual Conference and Exhibition at the San Francisco Civic Auditorium, March 17-21. Information from the Association, 1061 M & M Building, Houston 2, Tex.

National Society of Professional Engineers. Spring Meeting at Michigan State University, East Lansing, Mich., February 13-15. Inquiries to Kenneth E. Trombley, NSPE, 2029 K Street N.W., Washington 6, D. C.

University of Colorado. Thirty-first Annual Highway Engineering Conference at the University Memorial Center, Boulder, Colo., February 27-28. Write Roderick L. Downing, Conference Chairman, 207 Engine Building No. 1.

University of Illinois. Forty-fourth Annual Illinois Highway Engineering Conference, February 25-27. Tenth Annual Illinois Traffic Engineering Conference, February 27-28. Both at the University's Urbana Campus.

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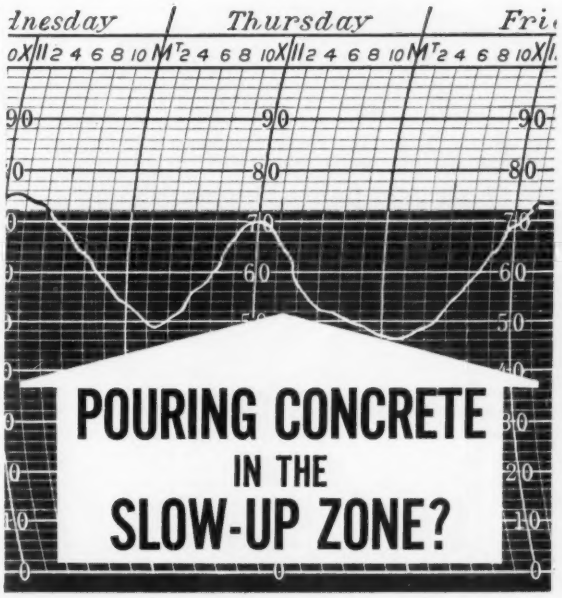

Add SOLVAY CALCIUM CHLORIDE *to Avoid Costly Delays!*

When temperatures vary from 70° down to 50°—it spells "SLOW-UP" which means costly delays in your concreting operations. This drop below 70° sharply decreases strength development and lengthens the waiting period before finishing.

A drop from 70° to 50°, for example, cuts 3-day strength up to 40%. To prevent this, add a low-cost 2% of SOLVAY Calcium Chloride to your concrete.

With this acceleration, concrete poured at 50° has a 3-day strength up to 40% *greater* than ordinary concrete cured at the ideal temperature of 70°!

When you use SOLVAY Calcium Chloride, you do away with overtime finishing, delays in form removal, delays between operations. You save up to 50% on protection time. And you get *better* concrete—increased in *both* early and ultimate strength—with lower water-cement ratio for more moisture-and-wear-resistant concrete.

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SOLVAY Calcium Chloride accelerates, but does not change the normal action of portland cement. Tests by the National Bureau of Standards proved its advantages in cold weather concrete construction. It is recommended by leading authorities, including American Concrete Institute and Portland Cement Association.

Write now for full data!

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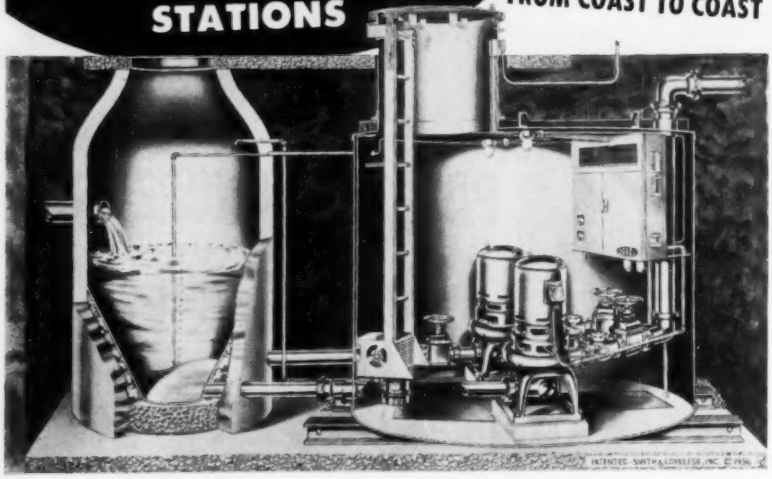

Smith & Loveless specialize in building America's finest sewage lift stations. Acceptance proves their quality. Smith & Loveless offer a complete line of six standard size lift stations with capacities from 20 G.P.M. to 1600 G.P.M. per pump or ejector. Larger capacity stations are built to your order.

- An integrated design, each piece proven by the test of time
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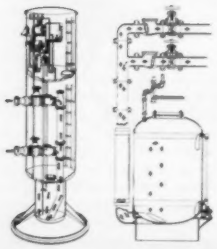
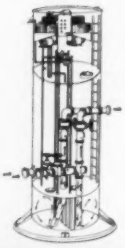


Write for a free copy of the Smith & Loveless sewage lift station data manual. Contains over 100 pages of design notes, selection charts, dimension drawings, specifications, diagrams, and a list of installations in 40 states.

A card to Dept. 80 will bring your data manual promptly. No obligation.



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New Publications

Flood control . . . Three new bulletins have been added to the list of United Nations publications on Hydrology in Asia and the Far East. Now available are the "Proceedings of the Regional Technical Conference on Water Resources in Asia and the Far East" (Flood Control Series No. 9), "Glossary of Hydrologic Terms used in Asia and the Far East" (No. 10); and "Multiple River Basin Development, Part 2B", (No. 11). Copies are available from the International Documents Service, Columbia University Press, 2960 Broadway, New York 27, N. Y., at $4.50, 40 cents and $1.50 respectively.

Standards . . . "Standards Are Everybody's Business" is the title of a 103-page booklet published by the American Standards Association (70 East 45 St., New York City). In it 33 industrial leaders, scientists and engineers discuss the vital role of standards in our major industries. The papers were first presented at the Seventh National Conference on Standards held in October 1956 in conjunction with the 38th annual meeting of ASA. The book may be obtained from the ASA at $4.00 a copy.

Industrial water . . . The important problem of the disposal and reuse of industrial water is considered in a new publication of the American Society for Testing Materials. Papers published in the bulletin were originally presented at the Second Pacific Area Meeting of the ASTM. Copies at $2.00 may be obtained from the ASTM, 1916 Race Street, Philadelphia 3, Pa.

Sewer planning . . . Basic steps in the planning and installing of adequate sanitary systems are clearly described in a new illustrated booklet published by the Clay Products Association. The free 12-page brochure, entitled, "Planning for New Sewers", may be obtained from the Association, 100 N. LaSalle St., Chicago 2, Ill.

Hydrology . . . The proceedings of the 1957 conference on New Research Methods in Hydrology, held at Scripps Institute of Oceanography in February, has just been released. The conference was one of a series under the sponsorship of the University of California's Statewide Committee on Water Resources. For information write the Committee on Research in Water Resources, University of California, Berkeley, Calif.

Structural research . . . Current research projects at the University of Illinois Engineering Experiment Station are detailed in three recent bulletins of interest to structural engineers. "The Static Strength of Rivets Subjected to Combined Tension and Shear", by William H. Munse and Hugh L. Cox; "Torsional Properties of Steel at High Rates of Strain" by Paul G. Jones and Thomas J. Dolan; and "Moments in Simply Supported Skew I-Beam Bridges" by T. Y. Chen, C. P. Siess and N. M. Newmark. They are available from the Engineering Experiment Station at the University of Illinois (Urbana, Ill.) at 45 cents, 35 cents and $1.00 respectively.

Water for mixing concrete . . . Four Corps of Engineers laboratories have studied the effects of the pH values of water on the strength of concrete and the staining properties of elements found in water. The results of their experiments are now available in the Waterways Experiment Station booklet identified as Technical Report No. 6-440. Requests should be sent to the Waterways Experiment Station, Vicksburg, Miss. Copies are 50 cents each.

Highway research . . . Up-to-date reports on the use of aerial surveys and photogrammetry in highway location and design are presented as Bulletin 157 of the Highway Research Board. The illustrated bulletin contains seven papers on the subject presented at the 36th annual meeting of the Board. Copies may be obtained for $1.00 each from the Highway Research Correlation Service, Highway Research Board, 2101 Constitution Avenue, Washington 25, D. C.

Denver's Coliseum...

Illustrates Versatility of Concrete for Arena Buildings

Denver's Coliseum is a handsome example of the functional use of concrete for arenas requiring uninterrupted enclosed space with minimum maintenance. Its arched construction requires no supporting pillars and provides a clear and unobstructed view of the entire arena area. Only concrete, the completely plastic building material, can be so molded and formed into any shape with all of its strengthening reinforcement inside.

Throughout the long years of its life, this concrete building will be virtually maintenance-free—a joy both to taxpayers and to spectators who attend the public functions held therein.

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Engineering Manpower . . . The current national shortage of scientists and technical personnel has prompted a unique and valuable study by nine Harvard graduate students, based on a comprehensive survey of practices and policies of American industry that effect the productivity of its engineers. The results of the study are now available in a report, entitled "Engineering Manpower—How to Improve Its Productivity". Copies of the limited edition are available at $16.00 each from Engineering Manpower Reports, P. O. Box 161, Cambridge 38, Mass.

Pollution control . . . Proceedings of the Fifth Southern Municipal and Industrial Waste Conference is now available. The conference—sponsored by Duke University, North Carolina State College and the University of North Carolina—brought together officials of industry and government for discussion of their respective responsibilities in pollution control. Copies of the Proceedings, at $1.50 each, are available from the Department of Sanitary Engineering, School of Public Health, University of North Carolina, Chapel Hill, N. C.

Evaporation research . . . A compilation and brief summary of evapo-transpiration research projects conducted in the United States and other countries have been prepared by John R. Davis, assistant professor of agricultural engineering at Purdue University. The 87-page report will be most helpful to persons interested in water management research. Copies are available from the American Society of Agricultural Engineers, 420 Main Street, St. Joseph, Mich. The price is $1.00 postpaid.

Faculty salaries . . . A new report on "Salaries and Earnings of Engineering Teachers, 1956" has been prepared by William H. Miernyk and Morris A. Horowitz for the ASEE. Copies at 25 cents. American Society for Engineering Education, University of Illinois, Urbana, Ill.

Abstracts . . . Recently, the Building Research Institute inaugurated "Abstracts of Building Science Publications". To obtain this quarterly review write to BRI Abstracts, Building Research Institute, 2101 Constitution Avenue, Washington 25, D. C.

Engineering tables . . . A 500-page "Handbook of Engineering Tables" published by the American Society of Mechanical Engineers, is now available from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. The book, edited by Dr. Jesse Huckert, was selected as one of the 100 best technical books of 1956 by the Science and Technology Division of the New York Public Library. It provides a compact source of basic data on metals engineering. The price is $12.00 a copy.

Highway officials and engineers . . . The 1957 edition of the ARBA directory of "Highway Officials and Engineers" is now available. This helpful pocket-sized reference contains the names, titles and addresses of more than 1,500 engineers and administrative officials with the state highway departments, and lists the engineers and administrative personnel of the Bureau of Public Roads and toll road authorities. Copies are $1.00 each and may be obtained from the American Road Builder's Association, 600 World Center Building, Washington 6, D. C.

Welded fabric in building . . . The use of welded fabric in reinforced concrete building construction is discussed in a newly revised edition of a design manual published by the Wire Reinforcement Institute. Free copies may be obtained from the Institute, Dept. 50, 1049 National Press Building, Washington 4, D. C.

Information received before March 15, 1958, will appear in the 1958 Directory

FOR ASCE MEMBERSHIP DIRECTORY

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Applications for Admission to ASCE Dec. 2-Dec. 28

Applying For Member

Irving Saul Backler, Montreal, Que., Canada.
John Reasoner Barry, Boise, Idaho.
Henry Joseph Bishop, New Bedford, Mass.
Carlos Claure-arze, Cochabamba, Bolivia.
Prabhat Kumar De, Calcutta, India.
Robert Melton Dixon, Austin, Tex.
Robert Balch Foster, Jr., Falls Church, Va.
Denes Gellert, New York, N. Y.
Charles Gogolick, New York, N. Y.
David Hamilton Gregg, Ogden, Utah.
Carl Paul Kroboth, Lexington, Ky.
John Jackson Leslie, St. Louis, Mo.
John Naylor, Ecuador, South America.
Harry Wallace Poston, Chicago, Ill.
James Henry Reynolds Jr., Boston, Mass.
Stanislaus Joseph Szymanski, New York, N. Y.

Applying For Associate Member

Mohammed Sheet Abdullah Al-imam, Baghdad, Iraq.
John Alle, Philadelphia, Pa.
Restan Mustafa Aras, New York, N. Y.
Leonardo Marcello Benevelli, New York, N. Y.
Euro Brando, Parana, Brazil.
Lynn Abbott Brown, Los Angeles, Calif.
Raymond Bruggink, Jr., Grand Rapids, Mich.
Edward Farrington Carpenter, Santa Rosa, Calif.
Alvin Kenneth Carter, Speedway, Ind.
Edward H. Castine, Buffalo, N. Y.
Frank Donald Ciccarelli, Pittsburgh, Pa.
Robert Morris Collins, San Bernardino, Calif.
John Boleyn Drewry, Newark, Del.
Donald Merrill Gwinnup, Anderson, Ind.
Robert Kenneth Harbar, Kansas City, Mo.
Guan-siu Hsiung, Princeton, N. J.
Herman John Koloseus, Iowa City, Iowa.
John Joseph Kuziw, New York, N. Y.
Aziz Hanna Labib, Cairo, Egypt.
Shiu Kee Loong, Hong Kong, China.
Donald Richard Martin, Myrtle Creek, Ore.
Philip Anthony Martinez, London, England.
Alan Hanson Mattock, Chicago, Ill.
George Hanson Obear, Baltimore, Md.
George Alfred Oliver, Colombo, Ceylon.
Ifeanyi Osili, Indianapolis, Ind.
Richard Morton Pearl, Redding, Calif.
Russell Allen Rea, Oklahoma City, Okla.
Frederick Henry Ruggles, Atlanta, Ga.
James Larry Simmons, New Orleans, La.
Charles Ferdinand Staudhammer, Chicago, Ill.
Johannes Steinvoort, Lindon, N. J.
Daniel Jacobus Venter, Walvis Bay, Union of South Africa.
Ford William Wheeler, Cleveland, Ohio.
Dah-cheng Woo, Ann Arbor, Mich.
Paul Curtis Wright, Versailles, Ky.
Roy Michihei Yamagishi, Oakland, Calif.
William Francis Young, Cortland, N. Y.

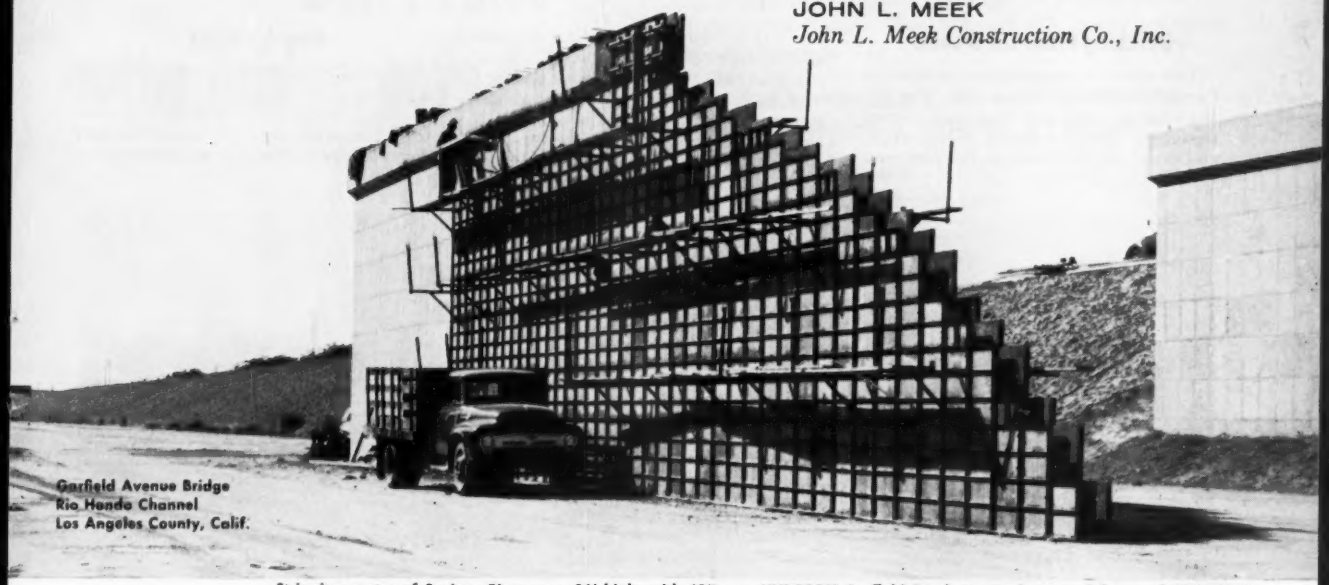
Applying For Junior Member

Lars Aadnesen, London, England.
Eugene Edward Brucker, St. Louis, Mo.
Donald Fountain Carney, Rolla, Mo.
Henry Hsu You Chen, New York, N. Y.
Carroll Marshall Crull, Columbia, Mo.
Joseph Edward Donnigan, Pittsburgh, Pa.
John Charles Floyd, Lincoln, Nebr.
John Robin Fowler, Melbourne, Australia.
Thomas Edward Giffels, Akron, Ohio.
Robert Edmund Hirsch, Milwaukee, Wis.
Richard Lyle Klitzke, W. Lafayette, Ind.
Kenneth Gene Kossieck, Decatur, Ill.
Francisco Javier Laborde Cancino, Urbana, Ill.
Cary Kau-Kei Mak, Berkeley, Calif.
Robert Arne Manseth, Portland, Ore.
Robert Arlen Northcutt, Oakland, Calif.
Seng Hin Quek, Sydney, N.S.W., Australia.
Carlos Luis Flamand Rodriguez, Urbana, Ill.
Thomas Stephen Rooney, San Francisco., Calif.
Jane Elizabeth Sawyer, Manchester, N. H.
Pierrepont Evelyn Sperry, Jr., Northumberland, Pa.
Otis Jennings Sproul, Orono, Me.
Carl Amundens Swanson, Philadelphia, Pa.
Saul Wechter, Monterey Park, Calif.
William Yim, San Francisco, Cailf.

[Applications for Junior Membership from ASCE Student Chapters are not listed.]

"my men were UNI-FORM **EXPERTS** *an hour after they began using them"*

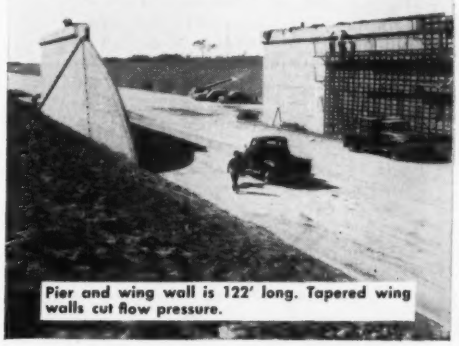
JOHN L. MEEK
John L. Meek Construction Co., Inc.



**Garfield Avenue Bridge
Rio Hondo Channel
Los Angeles County, Calif.**

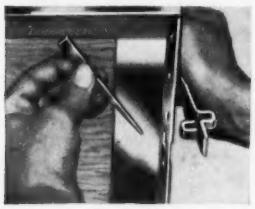
Stripping center of 3 piers. Piers were 26' high, with 40" cap. UNI-FORM Scaffold Brackets attach to steel frame of UNI-FORMS.

When inexperienced crews—men who have never used them before—can become expert in the handling and erection of UNI-FORM Panels in an hour or two, it means big savings in time and labor . . . faster job progress and lower all around costs. Simple mechanical assembly of UNI-FORM Panels permits fewer men to form more contact area per hour than is possible with any other job-erected forming system. The John L. Meek Construction Company's experience with UNI-FORM Panels is typical—quick mastery of the simple UNI-FORMING technique, resulting in faster forming with less labor. A good reason why more concrete is being formed every day with UNI-FORM Panels . . . why more contractors are using the UNI-FORM System for all their forming, regardless of type and size of the job. Write for the UNI-FORM Catalog—illustrates and describes the complete UNI-FORM System.

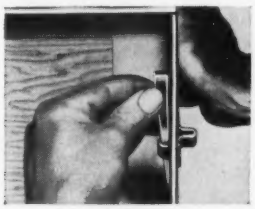


Pier and wing wall is 122' long. Tapered wing walls cut flow pressure.

UNI-FORM ASSEMBLY IS SIMPLE AS THIS:



1. UNI-FORM Tie Loop is placed into the square tie hole of Panel.



2. Tie Key is set into the Tie loop. This locks tie and Panel into 1 unit.

3. Bring next UNI-FORM Panel into position. Insert Tie Key in other Tie loop. Assembly is completed.

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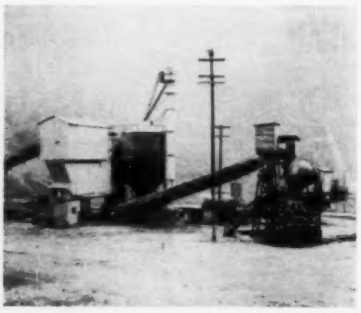
EQUIPMENT, MATERIALS and METHODS

NEW DEVELOPMENTS OF INTEREST AS REPORTED BY MANUFACTURERS

Batching Plant On Wheels

THE SWIFT HYDROELECTRIC PROJECT for Pacific Power and Light Co., Cougar, Washington, 45-miles from the closest ready-mix plant, required ready availability of quality concrete for construction of dam, power tunnel, intake and spillway structures, and two powerhouses. Available space for batching plants and aggregates storage at the river bank was limited. Noble-Mobile, a compact, 100% complete batching plant on wheels was driven to the site and put into operation at relatively low cost. The plant was used jointly by Jones-Tompkins, owner, and Guy F. Atkinson Co. Output was completely adequate for each contractor's needs; quality was consistent with the strict specifications of Bechtel Corp., engineers on the project; hauling distances were short, ranging from only a few yards to a maximum of 3 miles to the downstream powerhouse. On this project, the Noble-Mobile was a wet mix operation with a Smith 112-S tilting mixer charging to Dumpcrete trucks. Erected cost was far less than a conventional stationary central mixing plant. 3-in., 1½-in., and ¾-in. aggregates and sand were charged by a conveyor fed by a front end loader. Present cement storage capacity of 1,000 barrels (625 in plant, 375 in ground storage silo) was being increased to 3,000 barrels with the addition of a second ground silo. Aggregates bin storage capacity was 100 tons. **Noble Co., CE-2, 1800-62 7th St., Oakland, Calif.**



Compact and Complete

Multiple Selector Switch

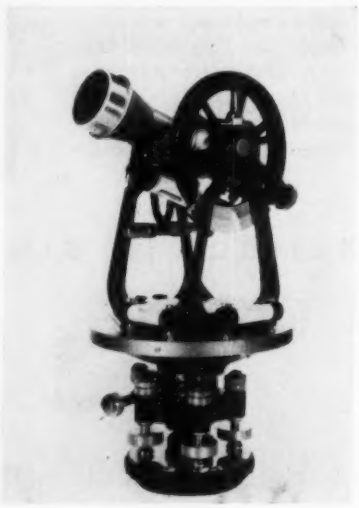
AVAILABILITY OF A HEAVY duty multiple selector switch, which consists of four outlets, each one controlled by its own switch, has been announced. Each pair (switch and outlet) is in a contrasting color for quick identification. This unit provides a handy control center for four separate pieces of equipment. It is equipped with a 10-ft neoprene heater cord and a fused plug. The replaceable sockets and switches are mounted in a hammertone brown drawn metal case. It is rated at 15-amp and 115 volts. **CBC Electronics Co., CE-2, 2601 N. Howard St., Philadelphia 33, Penna.**

Skyscraper Storage Tubes

THIRTY VERTICLE 80-FT pressurized oxygen storage tubes, newcomers in the steel industry, have been installed by Air Products, Inc., for Granite City Steel Co. The storage bank holds 125,000 standard cu ft of 99.5% purity oxygen, providing reserve oxygen for peak periods. Stored under 450-lb per sq in. pressure, the high-purity oxygen is generated at the steel company's new 60,000,000-cu ft per month generator, leased from Air Products. **Air Products, Inc., CE-2, P. O. Box 538, Allentown, Penna.**

New Eagle Transit

A JAPANESE TRANSIT, THE Eagle, is now on the market in the United States. Differing from the one manufactured for the past three years, it has a stadia arc, reversion telescope dial, and a ribbed horizontal plate. Two models are available—one with 20 sec graduations at $480 and the other with one min graduations at $459. **Texas-Asiatic Import Co., CE-2, 2127 Ft. Worth Ave., Dallas, Texas.**



Has Stadia Arc

New Scrapers

ESPECIALLY DESIGNED FOR HIGH-SPEED operation with Wagner TR9 and TR14 tractors, two new hydraulically-controlled scrapers are now in production. An exclusive feature for top performance with minimum strain on scraper and tractor is the "air cushion" accumulator built into the hydraulic system. This absorbs the shocks of high speed loading, yet provides positive control of cutting and spreading depth. A single front cylinder in the head frame raises and lowers front apron and controls rear apron discharge. A second cylinder on the rear hinged truck accurately controls cutting and spreading depth. Improved traction for fast loading and easy handling for high travel speeds is assured by the easily-mounted universal hitch which transfers scraper weight to the tractor rear driving wheels. **American Tractor Equipment Corp., CE-2, 9131 San Leandro Blvd., Oakland 3, Calif.**

"Air Cushion" Accumulator

Revolutionary Method For Hard Surfacing Parts

KENPLATE, AN ADAPTATION OF Kennametal cemented tungsten carbide that may have a far-reaching influence in the art of hard facing metal surfaces for protection against abrasion and wear, has been developed. The new material consists of small hexagonal plates of cemented tungsten carbide assembled in a continuous pattern on an adhesive glass fiber backing to provide flexible sheets or strips for application on flat or curved surfaces. The adhesive backing holds the small plates in position while they are being bonded by epoxy adhesives, silver solder, or conventional brazing materials to provide continuous surfaces that utilize the exceptional wear-resistance properties of hard tungsten carbide. **Kennametal, Inc., CE-2, Latrobe, Penna.**

"Don't raise the bridge, boys . . . LOWER THE RIVER"

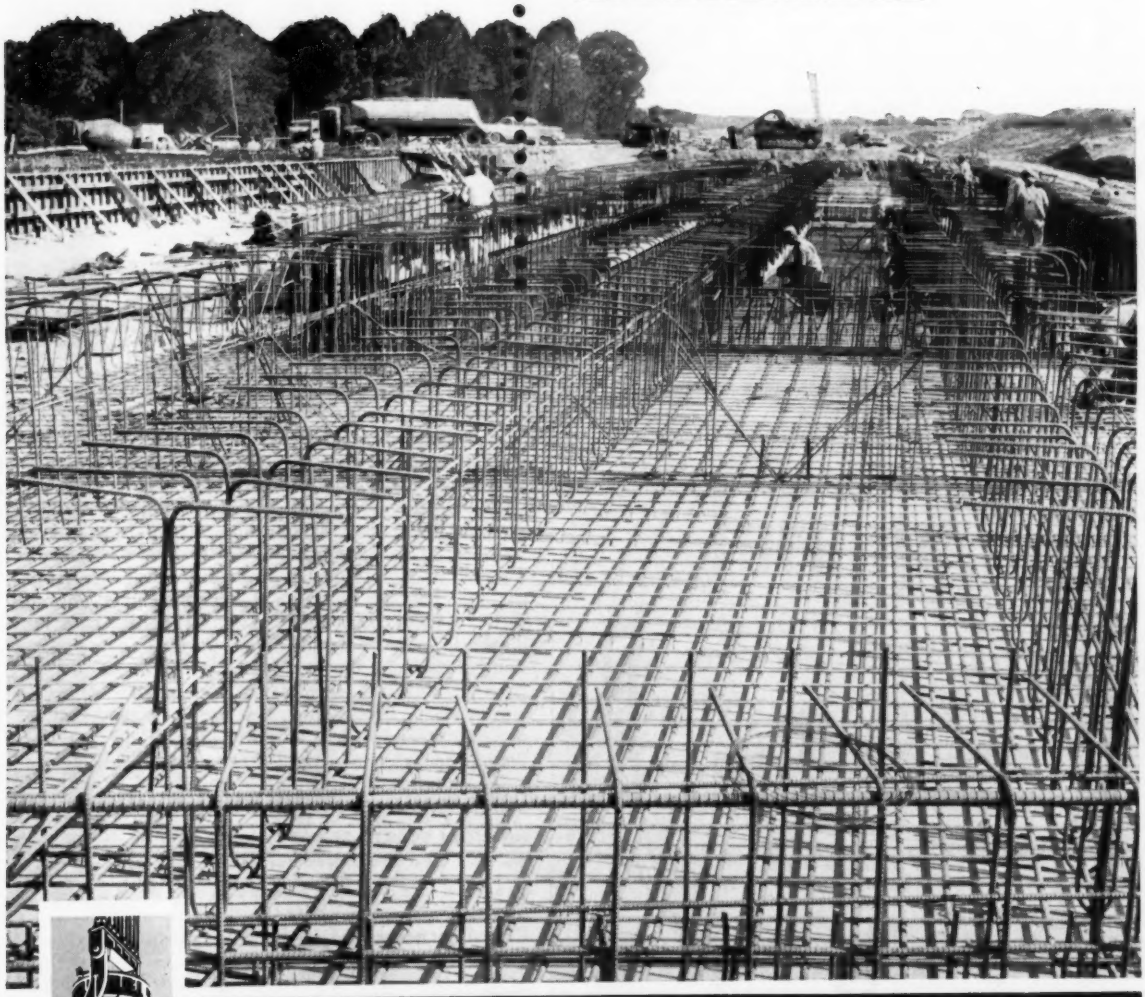
This favorite punch line of the old music hall comedian actually becomes a reality in the case of this new Highway 40 bridge which is being built right on the ground. Concrete pillars for the bridge are being poured into holes in the ground.

After bridge construction is complete, an underpass will be cut under the bridge. Only then will this unique structure really become a bridge.

FOR ALL HIGHWAY CONSTRUCTION, LACLEDE MAKES THESE STEELS:

- *welded dowel spacers*
- *multi-rib round reinforcing bars*
- *center joints*
- *tie bars*
- *recess joints*
- *accessories*

Missouri State Highway Commission
General Contractor: J. E. Latta Construction Company



LACLEDE

LACLEDE STEEL COMPANY

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Gear-Type Spindle

THE WORLD'S LARGEST GEAR-TYPE spindle couplings, designed and built by the Metal Products Division of Koppers Co., Inc., are integral parts of the new 32-in. rolling mill recently developed and put into operation by the Latrobe Steel Co. at Latrobe, Penna. This is the industry's first large rolling mill designed to roll superalloys for jet aircraft and missiles, and highspeed steels, the basic cutting material for modern metal-working. According to Latrobe, the mill could lead to significant increases in the production of these vital steels, thereby helping to solve a crucial problem in the missile age. Each of the two spindle couplings weighs nearly 5 tons and is about 10-ft long. The spindle shaft is over 14-in. in dia. Engineered into the Fast's coupling design are special curved faces on the hub teeth to allow large misalignment with minimum backlash, thus permitting unusually quiet and smooth performance even during reversing operations. These all-metal Koppers couplings employ unique end-ring seals to effectively retain the lubricant and keep out foreign matter. They can easily and quickly be disconnected, the company says, to permit rapid roll change and thus increase total production time. **Metal Products Division, Koppers Co., Inc., CE-2, Baltimore 3, Maryland.**

Incinerator Dump Body

A SPECIAL INCINERATOR DUMP body has been built for the city of New York. Its capacity is 15-cu yd. Construction is all welded steel of heavy gauge for continuous 24-hour operation. A heat-resistant paint is used as hot ashes are dumped directly from incinerator into the body. Ashes are wet down, therefore the body has a special watertight tailgate assembly air-operated by three air cylinders off the main air line and leak-proof drain ports. Ashes are taken to scows to be dumped at sea; to prevent spillage in transit, the load can be completely enclosed by hydraulically operated folding doors powered by four Daybrook sealed cylinders. Hoist for the body is a Daybrook Model 8B-150-50, 19-ton capacity, with double arm lifts. **Daybrook Hydraulic Division, L. A. Young Spring and Wire Corp., CE-2, Bowling Green, Ohio.**

Mercedes-Benz Diesel Engine

THE OM 315 MERCEDES-BENZ diesel engine is now available in the United States. Manufactured in the 82 to 127-hp range from 1200 to 1800-rpm, it is completely dependable 6-cylinder, vertical in line, 4-cycle, liquid cooled engine with a compression ratio of 18.5 to 1. Weighing 1775 lb with over-all dimensions of 46-in. high, 31-in. wide and 55-in. long, it provides the pre-combustion chamber type combustion system together with Robert Bosch injection pumps and nozzles. Fast starting in low temperature weather is possible through glow plugs which are standard equipment. **The Utica Division, Curtiss-Wright Corp., CE-2, Wood Ridge, New Jersey.**

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MANUAL 10 REVISED

CITY SURVEYING PROCEDURE STANDARDIZED

In any community, large or small, boundaries of the original land subdivisions form the basis of all subsequent property subdivisions. Thus, the need for a complete and somewhat standard "city survey" is essential to the successful operation or expansion of any community. Recognizing this very important need, Manual 10 was originally written, and has now been revised, for the purpose of describing the various divisions of a city survey, to furnish specifications for it, and to make recommendations as to accepted technical procedures. The new Manual 10 contains revised chapters on such basic topics as Triangulation, Traversing, Leveling, Topography, and Property Surveying; a new chapter devoted to the ever-growing field of Photogrammetry; and a new Appendix containing the different types of maps used in city planning.

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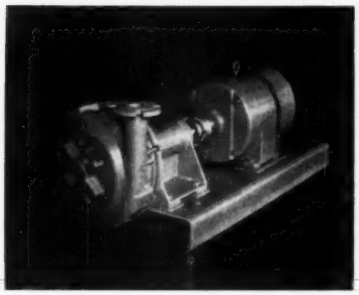
EQUIPMENT MATERIALS and METHODS

(continued)

Slurry Pump

A NEW MEDIUM-RANGE, high speed slurry pump, known as the Type BA, has been introduced for handling suspensions of sand, coal, crystals, silt, sludge, lime or chemical process slurries. An extension of the Morris line of heavy duty, low speed pumps, it is especially designed for pulp and paper, chemical,



Type BA

or other industries where both abrasion resistance and high speed are desired. Built in 1, 1½, 2, 3, and 4-in. sizes, the BA pump is available in cast iron, Ni-hard or stainless steel. It features a renewable suction liner and semi-open impeller. **Morris Machine Works, CE-2, Baldwinsville, New York.**

Land Clearing Tool

IN ACTUAL FIELD DEMONSTRATIONS the new land clearing blade has cut trees 81-in. in dia, leaving the stump sheared off cleanly at ground level or below. Known as the "Rome K/G Blade," it is designed for clearing reservoirs and lake-sites, rights-of-way, rangelands—in fact, wherever land clearing is required. It can also be used for building woods roads, fire breaks, and drainage ditches. A quick adjustment permits complete removal of stumps and root systems below ground level. This new tool cuts and windrows a wide swath of small to medium size trees in one continuous pass. Larger trees are cut individually. One of the most important advantages of the blade is that it can cut exceptionally large trees, by first splitting and weakening them with a sharp "stinger." Because the same tool is used for cutting and windrowing, the K/G Blade is much faster and more economical than other methods. **Rome Plow Co., CE-2, Cedartown, Georgia.**

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ZIMMER & FRANCESCON P. O. BOX 359, MOLINE, ILLINOIS

EQUIPMENT, MATERIALS and METHODS

(continued)

Flow Chart

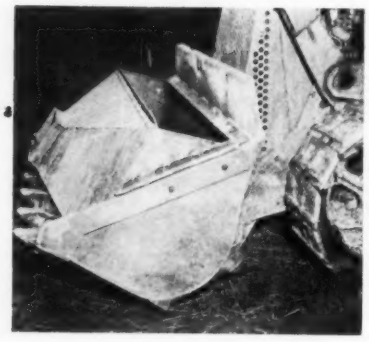
A NEW TYPE OF chart which gives direct graphic records of liquid flow has been developed for use with the Stevens Type F Water Level Recorder. This instrument with the new direct-reading flow chart is used for measuring sewage, industrial waste, irrigation water and other flows through Parshall flumes. Heretofore, only direct readings of surface fluctuations have been recorded and from this data the actual flow is computed. The new chart is graduated to give direct readings of flow in million gal per day or gal per min over various sizes of Parshall flumes. No mathematical conversion of surface level units into flow units is required when the recorder and chart are used in conjunction with Parshall flumes of standard sizes. The same recorder can also be used with charts reading in feet and hundredths to record head or surface fluctuations in lakes, streams and wells. **Leupold and Stevens Instruments, Inc., CE-2, 4445 N.E. Glisan St., Portland 13, Oregon.**

Borescopes

MODEL TG-2 BORESCOPES are slender instruments equipped with integral viewing heads. These scopes are designed for the internal inspection of small diameter cavities such as rifle and pistol barrels, exhaust tubes, hollow shafts and tubing. Various models are available with minimum bore diameters ranging from .160-in. to .280-in. and lengths ranging from 5-in. to 30-in. These instruments carry their own illumination in a low-voltage lamp in the viewing head. **Kollmorgen Optical Corp., CE-2, 347 King St., Northampton, Mass.**

Bucket Insert On Tractor

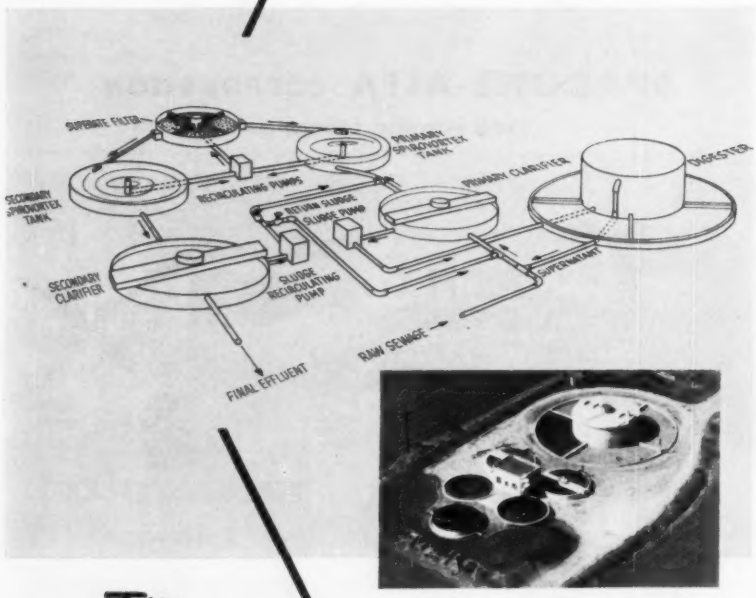
J. C. GODDARD, GENERAL superintendent of Johnson-Gaylon, Knoxville, Tenn., contractors, solved a troublesome construction problem recently by designing and fabricating a "home-made" concrete pour bucket insert to fit into a standard 1½-cu yd bucket of an International Drott TD-9 Skid-Shovel. Cost of the unique but effective insert was only $162, including material and labor. Need for the bucket attachment came when mixer trucks were miring down in soft ground while attempting to get close



Fast and Economical

enough to pour concrete pillars as part of the $400,000 addition being erected at the Jefferson City (Tenn.) Cabinet Co. Reasoning that a crawler tractor would easily overcome the soft soil, Goddard conceived the idea of the bucket insert, and designed and created it, using ⅛ steel. Formed to almost the exact shape of the standard TD-9 bucket, the insert is fastened securely to the existing bucket by two bolts. A pouring trough is fabricated in the front center of the rig, both to receive material from the mixer truck and to discharge it into the form. It takes only two men about 5-min. to install or remove the insert. **International Harvester Co., CE-2, 180 N. Michigan Ave., Chicago, Ill.**

IT'S NEW / It's from DORR-OLIVER



THE SPIROVORTEX SYSTEM
Incorporating The Superate Filter

A radically new and different approach to the treatment of domestic sewage and industrial wastes, the Dorr-Oliver SpiroVortex System contains many definite and proven advantages. It is especially suited where 90% B.O.D. removals are required. The headaches caused by bulking of sludge are eliminated as this new System produces an excellent settling sludge, regardless of whether the plant is overloaded or is operating under normal conditions. The high recirculation ratio over the Superate Filter means greater ability to handle changes in raw sewage characteristics under shock load conditions.

For a more complete picture of how the new Dorr-Oliver SpiroVortex System operates, write for a copy of Bulletin No. 7314 — just off the press. Dorr-Oliver Incorporated, Stamford, Connecticut.

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Dynion Filter

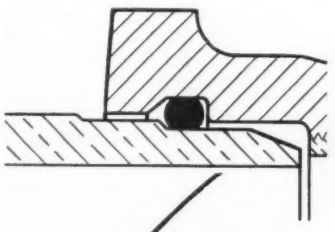
A NEW FILTRATION UNIT, that frees water of all algae and harmful bacteria as well as distasteful taste and odor, has been announced. The unit works by passing water through a Dynion active filter candle that is guaranteed in its germ-killing effect. The candle is a hollow tube of porous, ceramic material that is impregnated with activated silver ions. One end of the candle is closed. The open end is attached to a simple "direction-flow" manifold that forces all water to pass through the porous sides of the candle before being used. The sides act as germ-killing catalytic strainer surfaces, destroying all microorganic life in contact with them, and in the water surrounding them. The algae and bacteria that collect on the surfaces are filtered out. The candles can be cleaned with warm water. The self-sterilizing property eliminates any need of re-sterilizing. By adding an activated carbon element undesirable odor and taste can be removed from the water. **Water Conditioning Division, J. H. Scharf Mfg. Co., CE-2, 6120 Binney St., Omaha 4, Nebraska.**

Largest Unified Highway Sign Program

MORE THAN ONE MILLION dollars worth of all-aluminum highway signs, supporting structures, and road markers are being constructed in the largest single, unified highway sign program in the nation, designed to make the new 129-mile, $460 million Connecticut Toll Road one of the safest and most clearly marked turnpikes in America. Some 4,000 dark blue and dark green signs with intensely reflective letters, and employing a number of highway sign advances, will guide motorists on the new highway, and its many interchanges and four-leaf clover intersections. About 3,000 two-piece trailblazers, distinctive emblems with arrows which point the way to the superhighway along its feeder roads are also on order. In addition, 12,000 delineators—small silver and amber-colored prismatic "cat's eyes"—will clearly mark the shoulders of the roadway and all curves and intersections. **Federal Sign and Signal Corp., CE-2, 8700 South State St., Chicago 19, Ill.**

Steel Strapping Cuts Cost of Casting Prestressed Concrete Beams

TENSIONING STRANDS CAN BE restrained from splaying outward during the tension relieving cycle by binding them with loops of Signode steel strapping. These are easier to apply and less costly than the hoops of reinforcing rod previously used. In a typical application, 5-ft of 1¼ x .035-in. heavy duty strap will replace 4½-ft of #6 reinforcing rod. Made of new billet steel, metal in such a hoop would cost 40 cents at carload prices. To this must be added the cost of cutting, bending and distributing hoops along the casting bed. Even when bought in the smallest available quantities, the loop of strap together with the necessary Signode seal will cost less than 6 cents. There will be no cost for fabrication. Distribution at the casting site is no problem since strap, seals and two simple tools are carried on a specially designed hand truck strap dispenser. **Signode Steel Strapping Co., CE-2, 2600 North Western Ave., Chicago 47, Illinois.**



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VALVES & HYDRANTS FOR

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M H

For installing M&H Valves and Hydrants in a Ring-Tite asbestos-cement pipe line, specify valves or hydrants with Ring-Tite end connections. The connecting ends of the valve or hydrant are especially designed to enclose a round rubber ring gasket when the end of Class 150 Ring-Tite pipe is inserted, as illustrated in sketch above. Non-rising-stem gate valves with Ring-Tite end connections are available either with conventional or "O"-Ring stuffing box.

Installation is easy and simple. Unskilled workmen can make up the connection quickly and economically. No special fittings nor extra joint materials are required. The joint is tight against low or high pressure. For full information, wire or write

M&H VALVE AND FITTINGS COMPANY
ANNISTON, ALABAMA

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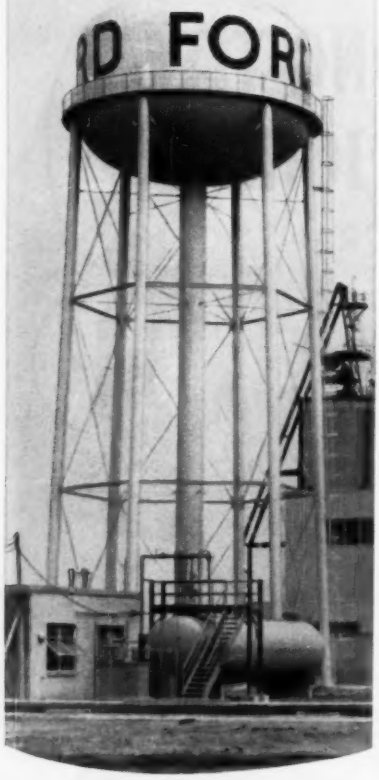

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EQUIPMENT MATERIALS and METHODS

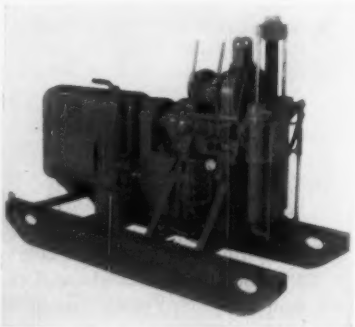
(continued)

Outside Density Cone

IN-PLACE MEASUREMENTS OF density of coarse-grained soils and gravels to be used for fill in dams, levees, airbases, road-beds and other heavy construction are made possible by a 12-in. sand density cone. Density is measured by the rate at which sand, funnelled through opposed twin cones, is compacted into a hole in the fill-material. The uniformity and rate of flow of the sand may be observed by the test operator through a transparent acrylic plastic chamber which threads into the upper cone. The lower cone has a flange allowing use of the apparatus on holes up to 12-in. in dia. Upper and lower cones are joined by a specially machined valve assembly. The large diameter of the apparatus permits the digging of a large density hole and facilitates the removal of material. It also makes possible a very high degree of accuracy in the density determination. **Soiltest, Inc., CE-2, 4711 W. North Ave., Chicago 39, Ill.**

Model "JS" Core Drill

DESIGNED WITH A LOW center of gravity and wide skids to offer maximum stability when drilling in rough terrain, the "JS" Core Drill is powered by a 134-cu in. 30-hp liquid cooled gasoline power unit and has a 6 volt electric starting system. It incorporates an integral 20-ft aluminum derrick and optional cathead. The drill is offered with either an "AW" or "NW" 24-in. feed hydraulic swivel head capable of handling the new Diamond Core Drill Manufacturer's Associations "W" series drill rods. **Penndrill Manufacturing Division, Pennsylvania Drilling Co., CE-2, 1201 Chartiers Ave., Pittsburgh 20, Penna.**



Model "JS"

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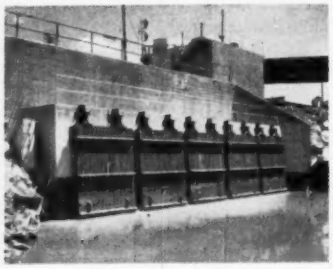
TIDE GATES



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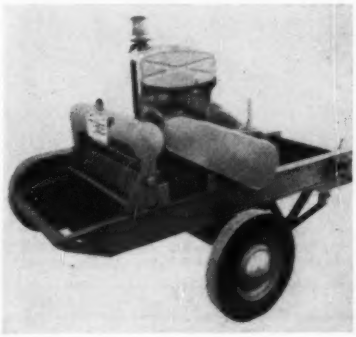
EQUIPMENT MATERIALS and METHODS

(continued)

Cleaner for Forms

A PORTABLE POWER-DRIVEN form cleaner designed to reduce form-cleaning costs to a minimum has been developed. According to the manufacturer, important savings result from the speed and thoroughness with which steel forms are cleaned. Known as the EFCO Form Cleaner, it works equally well on EFCO Steel Forms, Economy Steel Forms, or on most any panel form not exceeding 30-in. wide. In operation, the forms are



Power-Driven

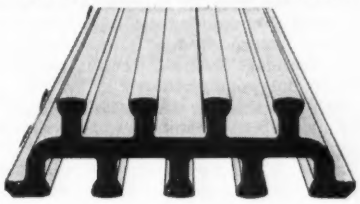
simply loaded on a conveyor belt which pulls them under a rapidly rotating steel wire brush. The forms are automatically cleaned and oiled, and the clean forms emerge from the far end of the conveyor belt ready for reuse. The machine is geared to clean forms at the rate of 42-lineal ft per min. It is clutch operated, trailer mounted and has a standard ball hitch with retractable leg for transporting. **Economy Forms Corp., CE-2, 4301 N.E. 14th St., Des Moines, Iowa.**

Trenching Machine

A NEW SELF-PROPELLED light trenching machine, the Model C Ditch Witch is powered by a 7-hp air cooled gasoline engine and will dig trench 3-in., 4½-in. or 6-in. wide to depths up to 2-ft. Trenching speed is about 4-ft per min. Completely mobile under its own power, it is easily handled on the job by one man and is small enough to go through a standard width gate for work inside fenced yards. The machine has been designed for installation of underground wiring, lawn sprinkler systems, gas services, water lines, telephone services, street lighting and signal systems. **The Charles Machine Works, Inc., CE-2, 608 Birch St., Perry, Oklahoma.**

LABYRINTH® WATERSTOPS

A SOUND INVESTMENT FOR CONCRETE CONSTRUCTION!



LABYRINTH AVAILABLE IN 2, 3 or 4 rib.

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1. Consider the investment in design, materials and labor (to mention a few).

2. Then consider how important safe, secure *watertight* concrete joints are.

3. Thorough watertightness *can* be secured by installing Labyrinth Waterstops—a dividend that makes the low initial cost of the product insignificant when compared to your total investment—and one that insures watertight concrete joints for years!

- Corrugated ribs grip concrete, insure an everlasting bond between joints.
- Finest polyvinyl plastic resists chemical action, aging, severe weather.
- Takes just seconds to nail to form . . . easy to cut and splice on location (prefabricated fittings available).
- There's a Water Seal product for every type of concrete work!

If your aim is to stop water seepage, *stop it effectively with Water Seals' Waterstops!*

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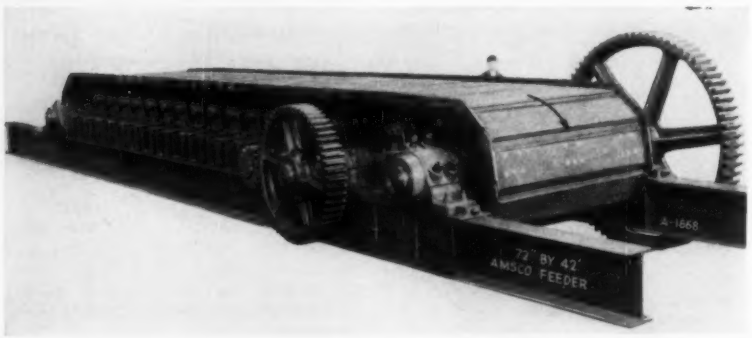
EQUIPMENT, MATERIALS and METHODS

(continued)

Giant Feeder

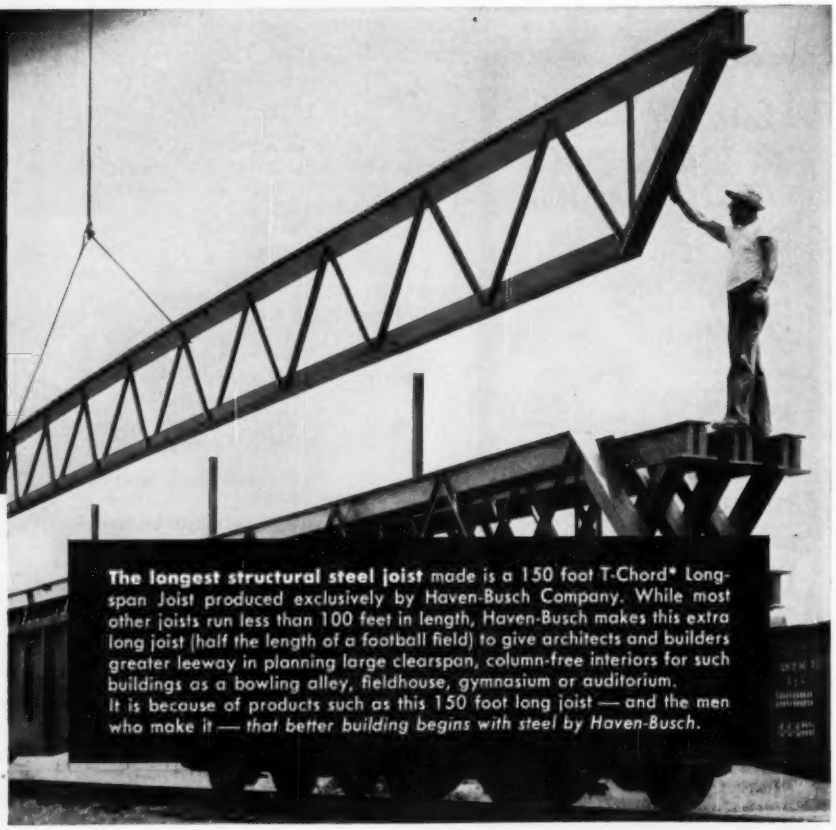
A HUGE AMSCO FEEDER, believed to be the world's largest, was recently completed. The machine is of a type used to receive ore and stone from storage bins or hoppers, feeding it to conveying and crushing facilities. It is basically heavy duty equipment consisting of a series of manganese steel pans, designed to carry ore for comparatively short distances over horizontal or reasonably inclined planes. The pans ride on two parallel endless chains also made of manganese steel. This is an exceedingly hard steel which has the characteristic of becoming even tougher with repeated pounding or hard usage. Able to handle 550-tons of ore per hour, it weighs approximately 180,000-lb, is 72-in. wide, 46-ft. long, and 10-ft. in height. **Stephens-Adamson Mfg. Co., CE-2, Aurora, Ill.**



Copyflex Whiteprinter

THE MODEL 575, A NEW, high speed whiteprinter with an extremely wide printing latitude, has been developed. The machine is equipped with a 5000 to 75000 watt selective switch controlled lamp, an adjustable lamp shield, a machine speed of 75-ft per min, and a large 46-in. printing width. This unit, with its powerful mercury arc lamp, augmented by the fast machine speed, increases average print production as much as 250%. Old tracings or new, tracings with varying degrees of translucency—the "575" can reproduce sharp, black-on-white prints from all of these quickly, easily and economically. A minor adjustment of the lamp shade, and any tracing, or group of tracings can be reproduced as fast as any skilled operator can maneuver. The large 46-in. printing width provides side-by-side feeding of small and medium sized tracings, which after exposure, are automatically stacked in the convenient tracing stacking tray. The prints, too, are automatically stacked in one of the print delivery trays. **The Charles Bruning Co., CE-2, 4700 W. Montrose Ave., Chicago 41, Ill.**

HOW LONG IS A LONGSPAN JOIST?



The longest structural steel joist made is a 150 foot T-Chord* Longspan Joist produced exclusively by Haven-Busch Company. While most other joists run less than 100 feet in length, Haven-Busch makes this extra long joist (half the length of a football field) to give architects and builders greater leeway in planning large clearspan, column-free interiors for such buildings as a bowling alley, fieldhouse, gymnasium or auditorium.
It is because of products such as this 150 foot long joist — and the men who make it — *that better building begins with steel by Haven-Busch.*

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*T.M. Reg.

EQUIPMENT MATERIALS and METHODS

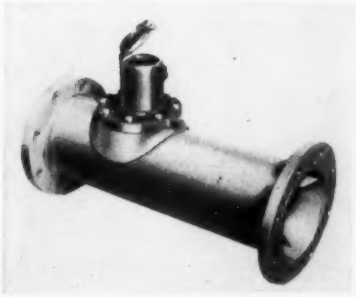
(continued)

Waste Treatment Unit

THE DORR-OLIVER COMPLETREATOR is a self-contained unit providing complete waste treatment facilities for small plants. Utilizing a standard two-stage bio-filtration flowsheet, this newly developed package plant will handle wastes of 150 persons or their equivalent in solids and B.O.D. It is particularly applicable to treatment of wastes from small housing developments, restaurants, service stations, military installations and schools. A completely assembled unit contained in an 11-ft 6-in. dia by 19-ft 9-in. high steel tank, it comprises a Dorr Duo-Clarigester annularly surrounded by two stages of high-rate trickling filters and equipped with two recirculation pumps and required electrical equipment. **Dorr-Oliver Inc., CE-2, Stamford, Conn.**

Main-Line Meter

A NEW MAIN-LINE METER, incorporating a powerful radial magnet, molded as an integral part of the propeller hub, has been developed. A companion magnet on the drive shaft of the meter permits motion to be transmitted to a sealed transmission from the propeller to the register. This sealed mechanism



Magnetic Propeller Drive

reduces friction and maintenance. This new direct mounted indicator-totalizer is a standard feature of the Sparling Masterflo meter. Available in 4-in. to 24-in. sizes, the meter's working pressures are either Standard 150 or 250-psi. **Sparling Meter Co., Inc., CE-2, 225 North Temple City Blvd., El Monte, Calif.**

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Acker's low-cost LD Core Drill was specifically designed for sensitive, hand lever feed drilling to permit even unskilled operators to recover core from broken difficult formations.

Even so, we were particularly gratified to learn from the Boring Soils & Testing Co., that their Acker LD Rig successfully obtained cores from extremely difficult coral rock formations in Bermuda. This, despite the failure of other rigs to obtain cores!

The LD is completely self-contained and is available for jeep, trailer, truck or skid mounting. It makes *diamond core drilling possible even in the roughest tertain!*

If you want more information about the Acker LD, please write for Bulletin 21CE.

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(continued)

Altite Joint

THE ALTITE JOINT WAS developed to fill the need for an inexpensive, simple and easily assembled joint, yet retain all features of joints of conventional design. It consists of only one accessory, a rubber gasket, which consists of a soft rubber O-ring with hard rubber tips made intergrally on opposite sides of the O-ring. The symmetrical shape allows the gasket to be placed in the gasket seat without any concern for installing backwards. Composition and dimensions of the gasket have been carefully determined to assure a tight and lasting seal. **Alabama Pipe Co., CE-2, Anniston, Alabama.**

Waveform Translator

A UNIQUE LABORATORY TOOL provides the means for accurate plotting of waveforms to 20-kc on conventional X-Y plotters. Static X-Y measurements may also be made. The unit is designed to accept signals from any oscilloscope, but may be used independently. An intensity strobe allows the operator to observe instantaneous plotting position on the scope trace. Placing the 3-position "Sweep" switch in "Manual" permits the strobe to be moved manually along the trace for static measurements or adjustment of the plotter pen position. Depressing the sweep switch momentarily to "initiate" causes the strobe to reset to the left side of the screen and to scan the trace automatically, plotting as it goes. Because it samples both the X and Y components, the Translator can plot complex lissajous patterns and hysteresis loops. Complete families of curves, such as transistor characteristics, can be obtained readily. Accuracy is determined by the characteristics of the scope and plotter with which it is used. The unit is fully transitorized and self-contained. **Transdata, CE-2, 1844 Brigden Rd., Pasadena, Calif.**

Utility Spray Tank

THE MODEL 101 UTILITY Spray tank is a real "cost-cutter" that combines three operations in one unit—bar spraying, with the standard 10-ft tubular bar with shifting mechanism or 8-ft mechanically operated full circulating bar; hand spraying; and pouring pot patching. It is perfect and profitable for municipalities and contractors, for repairing rural roads, patching city streets, and spraying driveways and parking lots. Operation is so simple that an unskilled operator can be checked out on it with a minimum of instruction, thus reducing the cost of road construction and maintenance. **Littleford Bros., Inc., CE-2, 453 E. Pearl St., Cincinnati 2, Ohio.**

Filter Pump Line

A LINE OF NEW SWIMMING pool pumps designed expressly to meet sand and gravel filtration requirements has been placed on the market. The pumps offer exceptionally high capacity at 30-ft head for back-washing filters. The line, designated as F-Series, consists of five models ranging from ⅓ through 1½-hp, suction sizes up to 2-in. A choice of in-line suction or integral strainer is offered. Other features include close-coupled construction with cast-iron components, deep-vaned, enclosed type impeller with large opening to pass solids up to ¼-in. and prevent clogging, and high shut-off characteristics making a maximum filter flow rate obtainable at high head. **Barnes Mfg. Co., CE-2, Mansfield, Ohio.**

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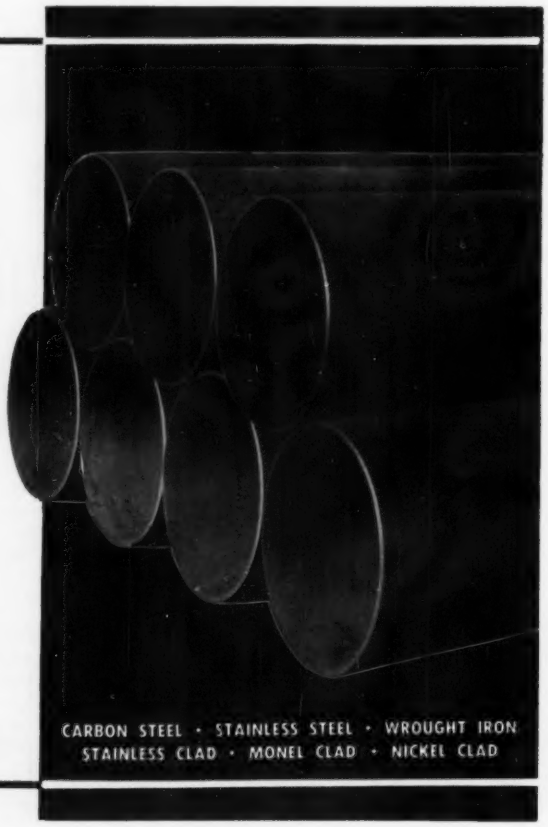

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Literature Available

STEEL PLATE CONSTRUCTION—Methods for high quality steel plate construction are described in a new 4-page pamphlet. The publication illustrates typical massive structures, such as coke drums, catalytic cracking units, a 225-ft dia Hortonsphere, reactor-regenerators, sulphite digesters and accumulators. One photograph shows a field stress relieving furnace, 34-ft in dia by 30-ft high, which was designed and fabricated especially for the erection of a Houdriflow unit. **Chicago Bridge and Iron Co., CE-2, 332 S. Michigan Ave., Chicago 4, Ill.**

TRANSPORTER—A four-page two-color booklet giving complete specifications and drawings of the low lift pallet Transporter, a walkie-type electric-driven industrial truck, Model WPY 4 and 6, has been released. Trucks described have lifting capacities of 4,000 and 6,000-lb, are only 29¼-in. long plus load and yet have a standard 15½-in. battery compartment, thus reducing aisle space requirements and improving maneuverability. **Automatic Transportation Co., CE-2, 149 W. 87th St., Chicago 20, Ill.**

REFERENCE HANDBOOK—The National Wood Tank Institute is making available a Reference and Data Handbook covering such subjects as the uses of wood tanks, their capacities, physical properties of wood and the chemical components of wood and their relation to expected service of wood tanks. This manual projects the use of wood to cover the most severe conditions found in chemical processing by the use of selected polymer linings. **National Wood Tank Institute, CE-2, 332 S. Michigan Ave., Chicago 4, Ill.**

DRILLING SUPPLIES—Catalog #58 describes several hundred drilling tools and accessories that can save any operator time and money on core drilling, soil sampling, etc. Complete specifications and distinct photographs are included. **Acker Drill Co., Inc., CE-2, Post Office Box 830, Scranton, Penna.**

MINE SHAFT EQUIPMENT—A colorful new 4-pg Bulletin No. 20-A on mine shaft equipment is being offered. Profusely illustrated with installation pictures and engineering drawings, it describes in detail the Mayo Koepe Hoist system as well as head frames, sinking frames, mine cars, etc. **Mayo Tunnel and Mine Equipment, CE-2, Lancaster, Penna.**

CUSHIONED VALVES—A new bulletin has been published which shows various piping and valve arrangements for particular applications, such as supply water to mill, accurate water level control in reservoirs, emergency fire protection, and isolating part or all of a system. **Golden-Anderson Valve Specialty Co., CE-2, 1207 Ridge Ave., Pittsburgh 33, Penna.**

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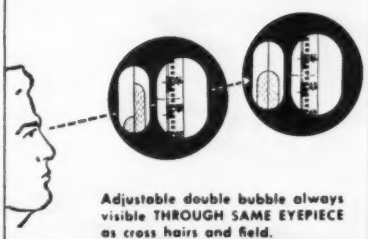

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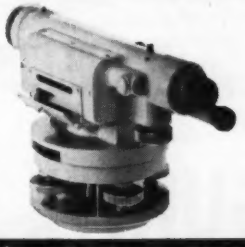

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Films Available

"The Road Ahead"—A new color motion picture designed to explain the U.S. highway program to the public, has recently been released. Narrated by popular commentator Walter Cronkite, the 23-minute film illustrates step-by-step how the 41,000-mi, $50-billion program will be planned, built and used. It shows how completed interstate highways will look and explains the provisions of the road program in easy to understand terms. Citizens of communities affected by the highways tell, in their own words, what results they got from the new roads. **Adv. Division, Caterpillar Tractor Co., CE-2, Peoria, Ill.**

"Steel in Concrete"—This is a new 16mm color-sound film which covers the theory and use of steel reinforcing bars in concrete structures. Actual laboratory demonstrations are conducted to show the effects of stresses and strains upon un-reinforced structures, interpreted and applied by the designing engineer and/or architect. The picture also shows the methods used to regulate the characteristics of new bullet reinforcing steel; for example, varying the chemical composition or by cold working the as-rolled bars to meet the requirements of individual applications. **Modern Talking Picture Service, CE-2, 3 East 54th St., New York 22, N. Y.**

Color TV Lighting—Lighting requirements for color motion pictures for color television were discussed by T. Gentry Veal of Kodak Research Laboratories before a regional meeting of the Society of Motion Picture and Television Engineers in Ames, Iowa. Veal told the audience that skin tone and facial detail, both of which can be enhanced by proper lighting, are often as necessary as dialogue in telling a story on color television. Through the use of an SMPTE color test reel, considerable experience has been obtained about many different kinds of color TV reproducing equipment, the scientist said. **Eastman Kodak Co., CE-2, 343 State St., Rochester 4, N. Y.**

"Water Conservation"—A new color-sound motion picture shows multi-purpose Gradall machines actually at work on a multiplicity of construction and maintenance jobs in irrigation districts throughout the West and Southwest and along various waterways of the nation. In this film are scenes showing irrigation work being carried out in such places as the Merced Irrigation District in California, the Teniente Water Improvement District in Texas and the Welton-Mohawk Irrigation District. **The Warner and Swasey Co., CE-2, 5701 Carnegie Ave., Cleveland, Ohio.**

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From the MANUFACTURERS

DISTRIBUTOR APPOINTED: Southern States Equipment Co., New Orleans, La., has recently been appointed as a Contract Distributor of McKiernan-Terry equipment, which includes pile hammers and extractors, light-weight leads and drive caps . . . **NEW PLANTS:** New plant facilities consisting of 40,000-sq ft of manufacturing area, were put into full production by the Stephens-Adamson Mfg. Co. at Clarksdale, Miss. The company engineers conveying systems and builds a broad line of bulk materials handling equipment . . . Homelite, a division of Textron Inc., has opened a new chain saw plant in Gastonia, North Carolina. Eye-catching on the outside, streamlined and compact within, the new 360-sq ft factory makes bold use of "straight flow" manufacturing techniques coupled with the latest automatic machinery . . . **EXPAND FACILITIES:** Construction has begun on a $2,000,000 expansion of facilities at the Kaiser Steel Fabrication Division plant at Napa, Calif., it was announced. When completed in 1959, the plant's pipe-making capacity will be nearly doubled, making it one of the largest plants in the world for fabrication of line pipe for petroleum and gas transmission . . . Continuing its policy of expanding sales and service facilities for Humdinger Pumps, the Ralph B. Carter Co. announces the acquisition of warehousing facilities in San Francisco, Calif. . . . The Tubular Products division of The Babcock and Wilcox Co. plans to expand and modernize its alloy and stainless steel making facilities with the addition of a new electric arc furnace and associated equipment, it was reported . . . **NEW ACQUISITIONS:** Ogden Corp. has announced the acquisition of The Eimco Corp. and the American Foundry and Machine Co., both of Salt Lake City, Utah. Eimco manufactures diesel and pneumatically operated overhead loading and excavating equipment. American Foundry and Machine is a producer of grey iron and steel castings . . . The Paulsen-Webber Cordage Corp., New York City, a leading supplier of wire rope for marine, aviation, contracting, and general industrial uses, has announced the purchase of the plant and assets of the Sunbury Wire Rope Manufacturing Co. at Sunbury, Penna. . . . **APPOINTMENTS:** Mr. Roy Hardy has been appointed to the position of Government Services representative for the Automatic Controls Division, Barber-Colman Co., Rockford, Ill. . . . The appointment of V. C. Otley as Director of Sales, Industrial Tar Products and Paving Materials, has been disclosed by Allied Chemical & Dye Corp. . . . J. D. Harmison has been made Sales Manager, Material Handling, Buda Division, Allis-Chalmers Mfg. Co. He has been Manager, Parts Sales, for the Tractor Group.

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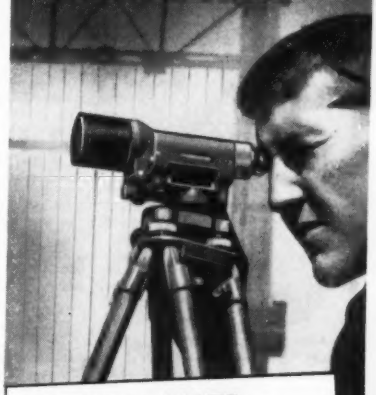

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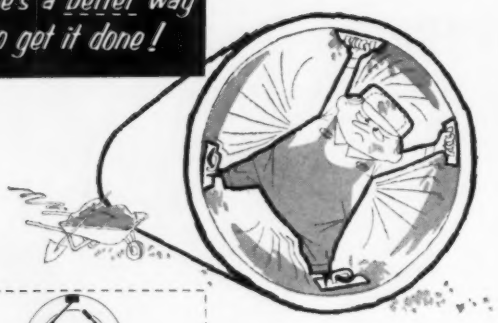

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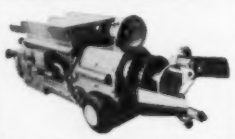

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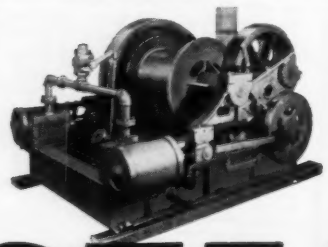

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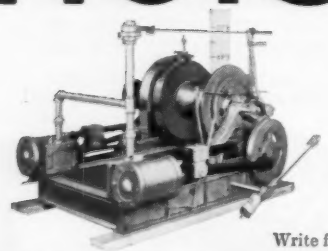

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December

1489. Computer Studies Penstock and Governor Systems, by Eldo C. Koenig and Howard A. Knudtson. (PO) A high-speed electronic differential analyzer is used to solve equations describing dynamic characteristics of a hydroelectric generating system.

1490. Economic Advancement Objectives, Final Report of the Task Committee on Study of Economic Advancement Objectives of the Board of Direction. (BD) This report is submitted by the task committee which was established by the Board of Direction to make a complete new study and investigation as to what the Society can do to improve the economic status of its members.

January

1494. Matrix Analysis of Beams, by Ray W. Clough. (EM) The application of a matrix procedure to the analysis of structures consisting of flexural members is presented in this paper. Four examples demonstrate the application of the method to various types of structures.

1495. Plastic Design of Cover-Plated Continuous Beams, by E. P. Popov and J. A. Willis. (EM) According to the plastic method of design, an infinite number of alternative designs of cover-plated continuous beams for the same applied load is possible. Several designs of two-span continuous beams were made, and experimental evidence was obtained to serve as justification for this method of design.

1496. Sea Bottom Pressure Fields Produced by Yawed Vessels, by P. M. Fitzpatrick. (EM) The flow around a stationary ellipsoid immersed in a semi-infinite fluid medium is examined. Approximation equations are given for the pressure distribution on the plane boundary and a procedure for obtaining constant pressure contours is presented.

1497. Teamwork in the Solution of Water Problems, by Harvey O. Banks. (IR) This paper presents aspects of teamwork in the uses of water, considering teamwork among agencies, and between professional groups and the public.

1498. Engineering in the Soil Conservation Service, by C. J. Francis. (IR) This paper outlines engineering activities of the Soil Conservation Service. Emphasis is placed on the engineering aspects of the new Watershed Protection and Flood Prevention Program, Public Law 566, which is administered by the Soil Conservation Service.

1499. Can Evaporation Losses be Reduced? by Earl Harbeck, Jr. (IR) A number of methods of minimizing evaporation losses are presented in this paper. Two methods that warrant intensive study are the use of a monomolecular film, such as hexadecanol, on the water surface, and the use of ground-water reservoirs for storage.

1500. Water Supply Versus Irrigation in Humid Areas, by M. C. Boyer. (IR) Watershed inventories are necessary to assure maximum beneficial use of the water supply, and to determine the present and future needs. White River Basin, Indiana, is so inventoried.

1501. Resolving Conflicting Demands for Water, by Samuel B. Morris. (IR) In arid areas of the world such as those of the Nile and Colorado Rivers, irrigation use creates major international problems. Domestic-industrial use can give the most benefits, but advanced planning is necessary to avoid conflicts.

1502. Importance of Phreatophytes in Water Supply, by C. B. Thompson. (IR) This paper outlines the occurrence and spread of salt cedar (tamarisk) over 440,000 acres in New Mexico. Water use and methods of eradication and control are examined.

1503. Factors Affecting the Useful Life of Reservoirs, by Carl B. Brown. (IR) The useful life of reservoirs includes length of life and service value. Controlling factors in reservoir silting are the capacity-inflow ratio and sediment content of inflow, which is governed by watershed characteristics. Flexibility in design and site conservation through proper project formulation is urged.

1504. Influence of Climate on Irrigation Agriculture, by Wayne D. Criddle. (IR) Climate is the major factor that determines whether irrigation is necessary in an area. Growing season rainfall may limit the amount of irrigation water needed, but may also create problems that do not exist where summer rainfall is scarce.

1505. Hydraulic Properties of Perforated Well Casings, by Yoash Vaadia and Verne H. Scott. (IR) This paper deals with the hydraulic performance of well casings of varied perforation characteristics. Several commercially perforated casings were tested in combination with various gravel envelopes. Results are presented and compared with criteria already available for well screens.

1506. Drainage in Relation to a Permanent Irrigation Agriculture, by C. R. Maierhofer. (IR) After trying for some 5,000 years to establish a permanent irrigation agriculture in arid lands, man finally has the knowledge and tools to assure success. Selecting lands for permanent productivity under irrigation is one practical answer.

1507. Methods of Computing Consumptive Use of Water, by Wayne D. Criddle. (IR) The more generally used methods for computing consumptive water requirements of crops are summarized, and data and charts that may simplify the application of methods are presented.

1508. Design of Folded Plate Roofs, by Howard Simpson. (ST) The procedure for the analysis of a single-span folded plate structure is reviewed and analyzed with the aid of an illustrative example. The effects of relative displacements of the longitudinal edges are considered.

1509. A Method of Design of Reinforced Concrete Sections, by Panagiotis D. Moliotis. (ST) A general solution is given in this paper

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of the calculation of any section of reinforced concrete with a symmetry axis, eccentrically loaded.

1510. Ultimate Strength Analysis of Long Hinged Reinforced Concrete Columns, by B. Broms and I. M. Viest. (ST) Theoretical analyses of the strength of slender concentrically and eccentrically loaded columns are presented and compared with existing test data. Both the effect of bucklings and the increase of eccentricity caused by deflections are taken into account.

1511. The Structural Properties of Magnetite Concrete, by Jerome M. Raphael. (ST) Structural design of a magnetite-concrete reactor shield depends on elastic and volumetric properties of the material. Principles are given for proportioning concrete mixtures made of crushed magnetite. Tests are described to establish the suitability of mixture under temperature and moisture conditions of the reactor, as well as elastic properties for design of steel reinforcement.

1512. Design of Masonry Walls for Blast Loading, by K. R. McKee and E. Sevin. (ST) The arching action theory of masonry walls is applied to the problem of blast resistant design. An equation of motion is developed for a masonry beam of solid cross section restrained by essentially rigid supports. Comparison is made with test data for walls subjected to full scale atomic and high explosive blasts.

1513. New Retractable Marine Fender System, by Palmer W. Roberts and Virgil Blancato. (ST) This paper presents details of a retractable marine fender system of a continuous timber vertical member and horizontal wale frame suspended by bolts in slotted brackets fastened to the pier. The outstanding qualifications of this system are large energy absorption, economy and permanence.

1514. The Columbia River Controlled, by Louis H. Foote. (WW) Planning by the Corps of Engineers for development of the water resources of the Columbia River Basin will consider changed conditions and needs since the Corps' report of 1948. This paper outlines these changes and the problems being encountered in providing long-range plans for resource development.

1515. Hydraulic Problem Solution on Electronic Computers, by Edward A. Lawler and Frank U. Druml. (WW) Applications are presented of three types of electronic computers, demonstrating the wide range of problems solved by these instruments. Tedious methods of solution are replaced by more accurate methods, thus freeing the engineer for true engineering problems.

1516. Closure of the Breach in Bayocean Peninsula, Oregon, by Harlan E. Brown, Jr., Gerald D. Clark, and Robert J. Pope. (WW) This paper examines the design and construction of rock and sand fill closure structures for Bayocean Peninsula, a natural barrier between Tillamook Bay and the Pacific Ocean, which was breached by storm waves.

1517. Flood Control in New England, by Alden K. Sibley. (WW) This paper considers flood-control methods employed for protection against both river and tidal flooding as related to the unique topographic, hydrologic, and economic characteristics of New England.

1518. St. Lawrence Seaway, 27-ft Canals and Channels, by W. Grothaus and D. M. Ripley. (WW) A historical summary of the 27-ft St. Lawrence Seaway is followed by an examination of the criteria adopted in design of the Seaway. Dams, locks, and channels of the project are presented with reference to these hydraulic criteria.

1519. Tentative Recommendations for Prestressed Concrete: Report of the Joint ACI-ASCE Committee on Prestressed Reinforced Concrete. (ST) The objective of this report is to recommend those practices in design and construction which will result in prestressed concrete structures that are comparable both in safety and in serviceability to constructions in other materials now commonly used.

1520. Discussion of Proceedings Paper 1138, 1157, 1290, 1292, 1399. (EM) Yoshiaki Iwasa, Alfred C. Ingersoll, Masashi Hom-ma on 1138. J. W. Delleur closure to 1138. Frank Baron closure to 1157. John H. Percy on 1290. Arne Selberg on 1292. S. J. Medwadowski on 1399.

1521. Discussion of Proceedings Paper 1104, 1105. (IR) Harry F. Blaney closure to 1104. George H. Hargreaves closure to 1105.

1522. Discussion of Proceedings Paper 1055, 1101, 1146, 1147, 1149, 1150, 1151, 1189, 1255, 1302, 1303, 1304, 1309, 1312, 1313, 1315, 1316, 1318, 1320, 1353, 1357, 1433. (ST) P. B. Morice and H. E. Lewis closure to 1055. No closure notice to 1101. Harry H. Hill closure to 1146. Frank Baron closure to 1147. Nan-Sze Sih closure to 1149. E. Chesson, Jr. and W. H. Munse closure to 1150. Harry Subkowsky closure to 1151. Eivind Hognestad closure to 1189. Louis Balog on 1255. Douglas T. Wright on 1302. H. S. Makowski, Thomas D. Y. Fok on 1303. P. W. Abeles on 1304. Irving Sherman on 1309. S. K. Ghaswala on 1312. A. Zaslavsky on 1313. E. Neil W. Lane on 1315. Milos Vorlicek and Jan Suchy, Ernest Basler, Rene E. Walther on 1316. Yeshayahu Etkin on 1318. Herbert A. Sawyer, Douglas T. Wright, Michael E. Fiore and Thomas R. Kuesel, Henri Perrin on 1320. Kurt H. Gerstle on 1353. E. Neil W. Lane on 1357. E. George Stern on 1433.

1523. Discussion of Proceedings Paper 1119, 1208, 1211. (WW) Alexander H. Kenigsberg closure to 1119. Otakar W. Kabelac closure to 1208. R. Silvester on 1211.

1524. Road Development in Ontario, by W. J. Fulton. (HW) Results of an engineering study which estimates the highway needs of Ontario for the next twenty years are given in brief. Organization of Department of Highways is outlined.

1525. Adaptability of Interchange Types on Interstate System, by Jack E. Leisch. (HW) This paper recommends types of interchanges based on analyses and comparisons of operational features and capacity potentials. A scheme is presented to provide operational uniformity in conjunction with exits on the interstate system of highways.

1526. Discussion of Proceedings Paper 1090, 1250, 1372, 1385. (HW) Paul Hartman closure to 1090. G. I. Sawyer on 1250. T. F. Hickerson on 1372. H. A. Abdun-Nur on 1385.

1527. The Administrative Role of the Federal Government in the Interstate System, by Frank C. Turner. (HW) Because it is not possible for 67 million motor vehicles to stay within the boundaries that have been set up to subdivide residents in urban areas, more effective cooperation must be developed across these boundaries if the highway program provided by the Federal Aid Highway Act of 1956 is to bring needed traffic relief.

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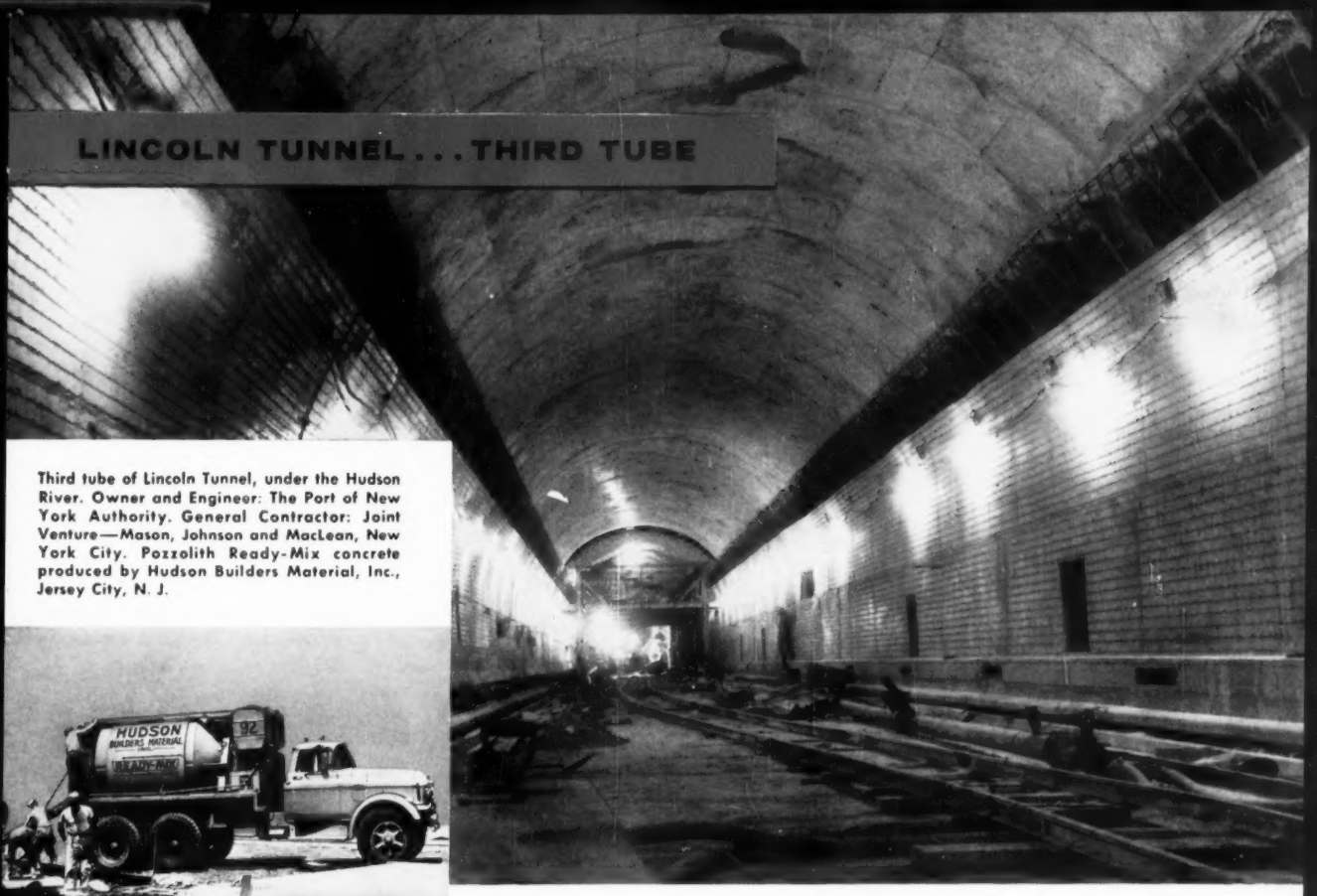
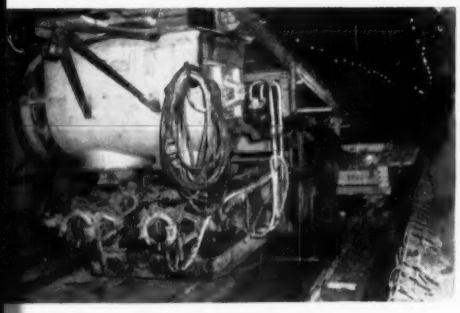


Third tube of Lincoln Tunnel, under the Hudson River. Owner and Engineer: The Port of New York Authority. General Contractor: Joint Venture—Mason, Johnson and MacLean, New York City. Pozzolith Ready-Mix concrete produced by Hudson Builders Material, Inc., Jersey City, N. J.

Ready-mix truck on top side of tunnel discharges concrete into "elephant trunk" . . .

Concrete goes down "elephant trunk" to buggies in tunnel . . .



Concrete pump receives concrete from buggies and pumps it into tunnel lining forms.

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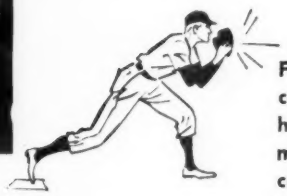

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